DOE/OR/01-1909&D3

Attainment Plan for Risk/Toxicity-Based Waste Acceptance Criteria at the Oak Ridge Reservation, Oak Ridge, Tennessee

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BECHTEL JACOBS COMPANY LLC
managing the
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ACRONYMS

ARAR	applicable or relevant and appropriate requirement
ASA	auditable safety analysis
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CSE	Criticality Safety Evaluation
DOE	U.S. Department of Energy
DQA	data quality assessment
DQO	data quality objective
EMWMF	Environmental Management Waste Management Facility
EPA	U.S. Environmental Protection Agency
FFA	Federal Facility Agreement
FS	feasibility study
HI	hazard index
K_d	solid-to-liquid partition factor
LDR	land disposal restriction
LLW	low-level (radioactive) waste
NT	North Tributary
ORR	Oak Ridge Reservation
QA	quality assurance
RCRA	Resource Conservation and Recovery Act of 1976
RA	response action
RI	remedial investigation
ROD	record of decision
SOF	sum of fractions
SRC	site-related contaminant
TDEC	Tennessee Department of Environment and Conservation
TSCA	Toxic Substances Control Act of 1976
UCL_{90}	90% upper confidence limit
UCL_{95}	95% upper confidence limit
VWSF	volume-weighted sum of fractions
WAC	waste acceptance criteria
WACFACS	Waste Acceptance Criteria Forecasting Analysis Capability System
WGF	Waste Generation Forecast

EXECUTIVE SUMMARY

On-site disposal is the selected remedy for the comprehensive management of waste generated from environmental restoration activities on the Oak Ridge Reservation in Oak Ridge, Tennessee. Radiological and chemical releases from wastes disposed in the Environmental Management Waste Management Facility (EMWMF) and the potential risks to the public from such releases are mitigated by the disposal cell design. Additionally, the wastes that will be accepted for placement are limited by a set of waste acceptance criteria (WAC). The overall WAC attainment process involves the completion of four separate sets of requirements:

- Administrative WAC are derived from applicable or relevant and appropriate regulations (ARARs) in the record of decision (DOE 1999), and from other agreements between the U.S. Department of Energy (DOE), the U.S. Environmental Protection Agency (EPA), and the Tennessee Department of Environment and Conservation (TDEC).

- Analytic WAC are derived from the approved risk assessment model in the remedial investigation/feasibility study (FS) (DOE 1998a) and FS addendum (DOE 1998b) for the EMWMF.

- ASA-derived WAC are derived from the facility authorization basis documentation for the EMWMF.

- Physical WAC are derived from operational constraints and contractual agreements between DOE's Environmental Management prime contractor (hereafter referred to as the prime contractor), and its EMWMF operations subcontractor.

This WAC Attainment Plan has been developed to define the overall process for ensuring that all regulatory agreements and risk- and hazard-based performance criteria are attained during disposal operations. The processes are constructed to do the following:

- analyze waste lots to determine concentrations and release parameters,
- determine the volume-weighted sum of fractions for current and future disposed waste,
- certify waste for on-site disposal or document why wastes could not be accepted,
- ensure all applicable land disposal restrictions are met,
- schedule EMWMF waste disposal and prepare and maintain waste placement records,
- perform and document required quality assurance/quality control measures, and
- calculate WAC concentrations for new radionuclides or chemicals.

The primary unit of waste to be considered for WAC attainment is the waste lot. A waste lot can be all or some of the waste of a particular waste stream removed from a Comprehensive Environmental Response, Compensation, and Liability Act of 1980 site, from an entire waste stream down to a single truckload of waste, a set of drums of waste, or even a single drum of waste.

There are several different entities that must be integrated in order for the waste approval and disposal process to function properly. DOE is accountable for WAC compliance as described in this document. DOE has delegated the responsibility to make WAC attainment decisions to its prime contractor, which it oversees and audits. The WAC Attainment Team, composed of prime contractor personnel, is responsible for determining whether waste lots can be accepted for disposal as proposed. WAC Attainment Team decisions include accepting the waste lot for disposal, recommending to projects that the waste lot be altered (e.g., segregating out hot spots for separate disposition), or requiring additional data in order to make a decision.

The prime contractor has in turn subcontracted the tasks of implementing response actions and operating the EMWMF and has flowed its contract requirements down to its various subcontractors. EPA and TDEC oversee and audit response actions and EMWMF operations, including the WAC Attainment Team decisions to authorize waste lots for disposal.

1. INTRODUCTION

On-site disposal is the selected remedy for the comprehensive management of waste generated from environmental restoration activities on the Oak Ridge Reservation (ORR) in Oak Ridge, Tennessee. The record of decision (ROD) for the disposal of ORR Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) waste (DOE 1999) documents the remedy selected, an engineered disposal facility in East Bear Creek Valley on the ORR for the consolidation of contaminated waste. This facility, the Environmental Management Waste Management Facility (EMWMF), will accept only wastes that meet the waste acceptance criteria (WAC) set forth in this document. Such wastes will contain low-level radioactive substances, Resource Conservation and Recovery Act of 1976 (RCRA) hazardous substances, Toxic Substances Control Act of 1976 (TSCA) toxic constituents, asbestos-containing materials, and combinations of these contaminants. The selected facility location is shown in Fig. 1.

The EMWMF has a nominal footprint of between 22 and 44 acres and is situated between North Tributary (NT) 3 and NT-5 north of Bear Creek. It consists of a 13-ft-thick multi-component cover and a 13-ft-thick liner consisting of a leachate collection/detection system, a 3-ft compacted clay foundation layer, and a 10-ft geological buffer. Figure 2 shows a representative vertical cross section depicting the main engineered components of the design.

Radiological and chemical releases from wastes disposed in the EMWMF and the potential risks to the public from such releases are mitigated by the disposal cell design. Additionally, the wastes that will be accepted for placement are limited by a set of WAC, which are divided into four categories: administrative, analytic, Autitable Safety Analysis (ASA)-derived, and physical. These WAC are derived from the various constraints placed upon the EMWMF. Specific data quality objectives (DQOs) for WAC attainment have been negotiated among the U.S. Department of Energy (DOE), the U.S. Environmental Protection Agency (EPA), and the Tennessee Department of Environment and Conservation (TDEC). The DQOs are summarized in Chap. 5 and described in detail in Appendix E.

The formal assessment of project data in a consistent manner is the necessary first step in determining compliance with the WAC DQOs. Formalized data quality assessment (DQA) techniques are summarized in Chap. 5, and detailed in Appendix C.

The various administrative, analytic, ASA-derived, and physical WAC are described in the following text.

1.1 ADMINISTRATIVE WAC

Administrative WAC are derived from applicable or relevant and appropriate requirements (ARARs) in the ROD, and from other agreements between DOE, EPA, and TDEC. In order for wastes to be disposed in the EMWMF, all administrative WAC must be met, or appropriate waivers must be obtained in the form of regulator-approved CERCLA documentation.

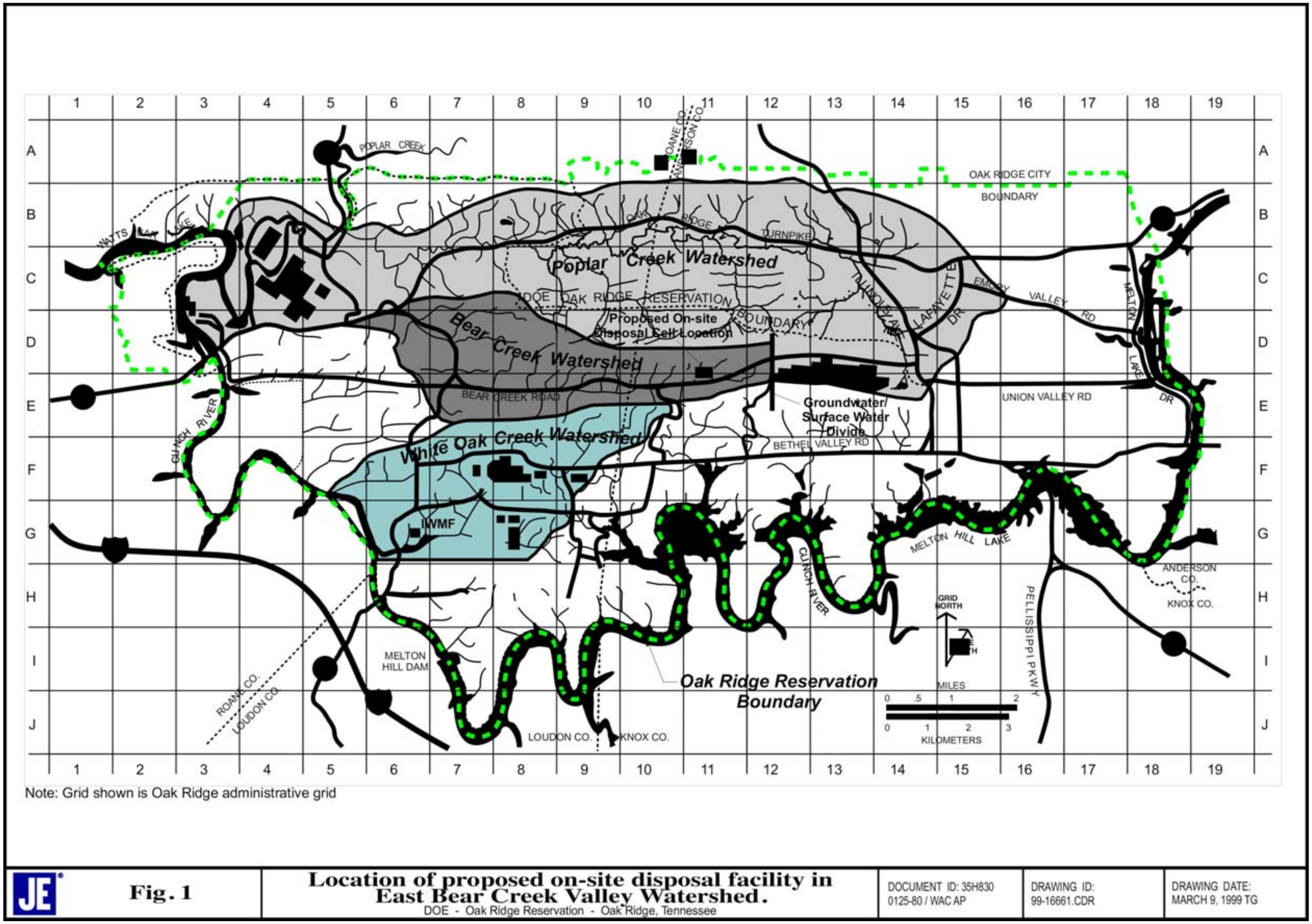


Fig. 1. Location of proposed on-site disposal facility in East Bear Creek Valley Watershed.

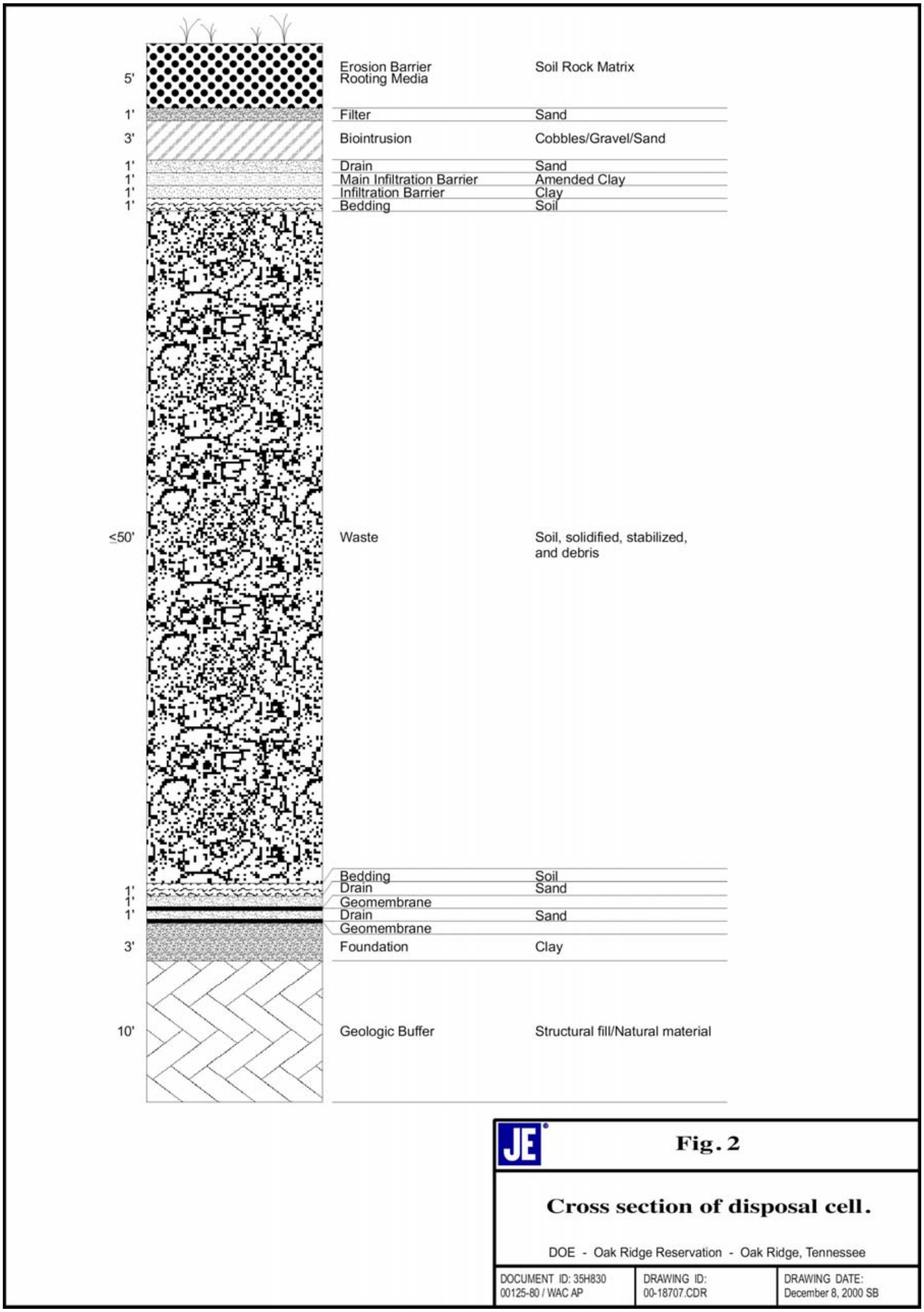


Fig. 2. Cross section of disposal cell.

One of the administrative WAC requirements is that all waste lots comply with RCRA land disposal restrictions (LDRs). Because RCRA is an ARAR, each CERCLA remedial action project, as a waste generator, will address RCRA LDR requirements within the context of the project's CERCLA decision documents. RCRA LDR compliance requires the following of a waste:

- that it does not exhibit a hazardous characteristic and is not a listed waste, and if so, does not have concentrations of hazardous constituents, underlying hazardous constituents, or listed constituents greater than LDR values, or

- that it has been treated to comply with those concentration values, or

- that it has obtained appropriate LDR waivers in the project's CERCLA documentation.

Other administrative WAC include the following:

- Wastes must be generated as a result of a CERCLA action.
- Wastes must comply with TSCA LDRs.
- Only low-level radioactive, hazardous, or mixed waste can be accepted.
- Transuranic wastes, high-level wastes, 11(e)2 byproduct wastes, and spent fuel rods are excluded.
- Wastes must remain subcritical during all phases of waste disposal.

1.2 ANALYTIC WAC

Analytic WAC are derived from the approved risk assessment model in the remedial investigation/feasibility study [(RI/FS) DOE 1998a] and FS addendum (DOE 1998b) for the EMWMF. In these documents, a concentration-based "analytic" WAC was established assuming a resident farmer receptor (WAC receptor). This farmer is assumed to use groundwater from a well between the facility and Bear Creek for domestic needs and surface water from Bear Creek for agricultural purposes. The EMWMF site conceptual model is presented in Fig. 3.

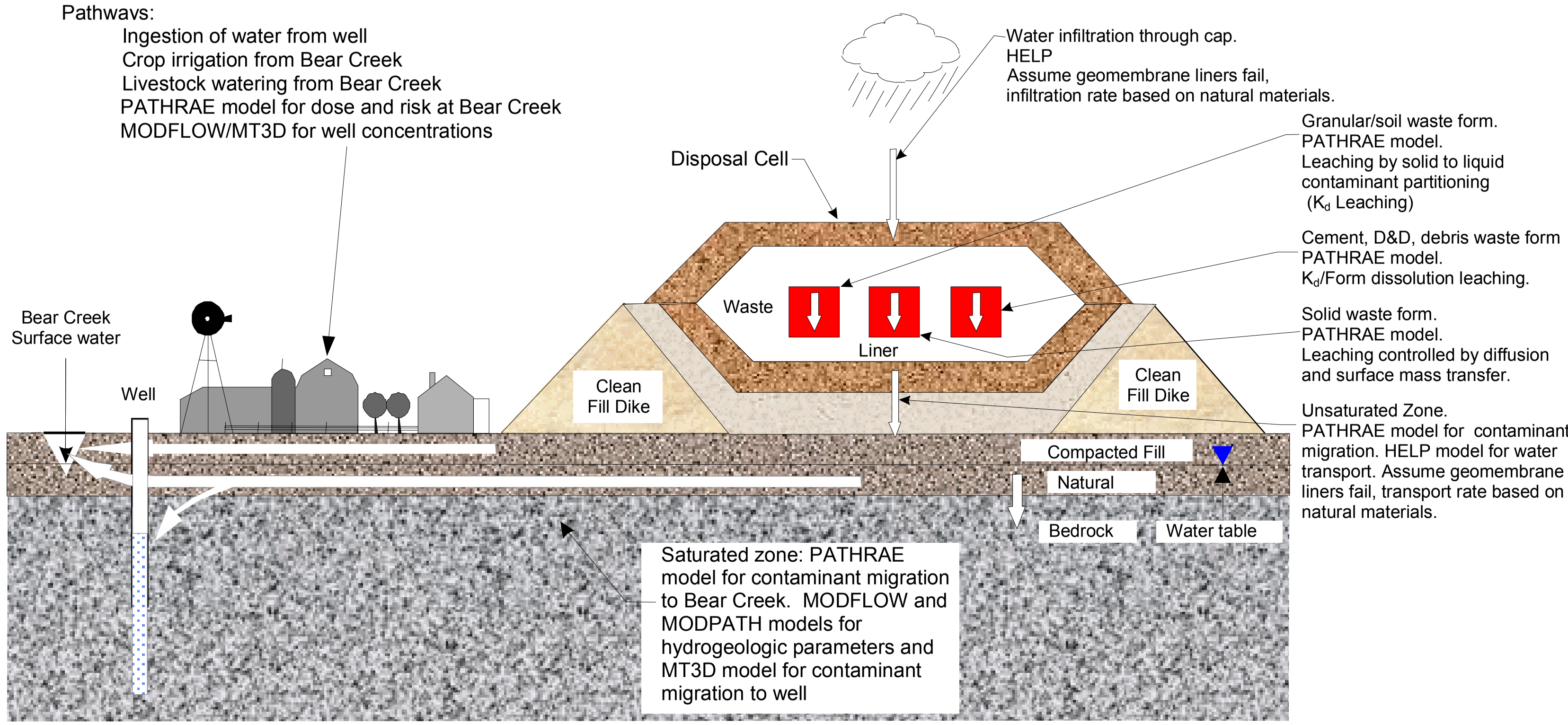
The EMWMF ROD (DOE 1999) set the following risk goals for the aggregate radiological and chemical impacts to this hypothetical receptor from all waste disposed in the EMWMF:

- the incremental lifetime cancer risk (carcinogenic risk) is to be $\leq 1 \times 10^{-5}$ and the hazard index (HI) is to be < 1 for the first 1000 years after closure, and

- the carcinogenic risk and HI are to be $< 1 \times 10^{-4}$ and 3, respectively, modeled from 1000 years to 100,000 years after closure.

To calculate analytic WAC, the EMWMF was conceptualized as one large waste cell containing a uniform concentration of a single contaminant. Risks were then calculated for this uniform concentration, and analytic WAC were back-calculated from these derived risks using the appropriate risk goals, based upon the time of peak risk and the type of risk being calculated (carcinogenic or HI).

Fig. 3. Contaminant leaching/transport analysis and exposure conceptual models.



The contaminant leaching analysis and site conceptual model used to develop risk-based WAC for the EMWMF required several predictions: the infiltration of water into the cell, the leaching of contaminants from the cell, the transport to the receptor well and Bear Creek, and the subsequent uptake by the receptor. Following are the main features, calculations, and models used in these analyses:

- Determination of water infiltrating the cap, passing through the waste, and entering the vadose zone and groundwater. This was accomplished by mass balancing analysis of precipitation/evapotranspiration, cap drain removal of water, and hydraulic flow, with the steady-state infiltration rate conservatively taking no credit for man-made cover and liner components. The HELP computer code (Schroeder et al. 1994) was used for these calculations.

- Solid-to-liquid partition leaching (Kd) of contaminants from soil. These were used as input to unsaturated, one-dimensional, time-dependent modeling of source leaching and contaminant transport in the waste and vadose zones to groundwater. The PATHRAE code (Merrell et al. 1995) was used for these calculations.

- Evaluation of groundwater flow characteristics in the EMWMF area and contaminant travel time to tributaries or Bear Creek. The three-dimensional, finite difference, time-dependent MODFLOW (McDonald and Harbaugh 1988) and MODPATH (Pollock 1989) models, respectively, were used to provide input for groundwater solute transport modeling, which used the PATHRAE code.

- Discharge of groundwater to tributaries and/or Bear Creek, solute mixing with tributary/stream flow, and contaminant uptake by receptors. The PATHRAE code and surface water flow data were used for these calculations.

- Calculation of risk for a resident farmer (WAC receptor) using contaminated well water for domestic purposes and contaminated Bear Creek water for agricultural purposes. The PATHRAE code and the EPA CERCLA slope factors were used for this calculation.

Additional details of the risk models and methodologies used to derive analytic WAC can be found in the approved RI/FS (DOE 1998a), Appendix E, and FS addendum (DOE 1998b), Chap. 2.

To ensure both carcinogenic risk and HI toxicity goals are met, separate analytic WAC concentration limits for individual radiological and chemical constituents are calculated. These limits correspond to the maximum permissible concentration of the constituent that could be placed in the facility if the waste containing the single constituent were to occupy the entire disposal cell volume in a soillike matrix. Analytic WAC values for constituents likely to be disposed in the EMWMF are presented in Appendix A for the soil waste form.

These soil WAC will be used conservatively for all waste forms (soillike, stabilized, solidified, debrislike, etc.) unless the Federal Facility Agreement [(FFA) DOE 1992] parties for a particular response action (RA) project concur with the use of waste-stream specific WAC concentrations that are calculated based on reduced leachability of the wastes relative to soil leachability. Such concurrence will be documented in the CERCLA documentation for that project. One specific case where this may apply would be when waste-stream-specific measurements of K_d are available; these measurements could then be applied using the analytic WAC modeling process in Appendix B. In cases where treatment of radionuclides is used to justify an increased waste-stream-specific WAC, the treatment chosen must be demonstrated to be effective for the duration of the hazard.

Because the wastes will contain multiple radionuclides and chemical contaminants, it is necessary to calculate a sum of the ratios of the concentration of each contaminant to its corresponding WAC concentration and then to sum these fractions to determine the aggregate effects of all waste contaminants. Since there are two sets of analytic WAC—carcinogenic and HI—two independent sums of fractions (SOFs) must be calculated.

Finally, since the disposal cell will ultimately contain wastes from multiple projects, each having different contaminants and volumes, the volume-weighted sums of fractions (VWSFs) must not exceed 1 for the wastes disposed. When both the carcinogenic and HI VWSFs are less than 1 for the period of interest, the performance criteria of the ROD are attained for both risk and toxicity. A 3-year projection of waste volumes and SOFs will be used, along with the volumes and SOFs of materials already placed in the cell, for compliance with this WAC attainment plan. Other time periods of interest may be used for planning purposes only.

1.3 ASA-DERIVED WAC

As part of the development of the DOE facility safety authorization basis for the EMWMF, an ASA and supporting Hazard Categorization were produced that include operational limitations on the releasable inventory of radionuclides that can exist within the facility at any one time. The ASA calculated that the total material at risk for release during a bounding-case, off-normal event would be 35 yd^3 (27 m^3) of a soillike material which could be released during a hypothesized very high wind event (i.e., a tornado). This volume of material was then converted to a mass of 4.05×10^7 grams, and waste concentrations were used with this mass to relate the potential releases to the Nuclear Category 3 Threshold Quantities in DOE-STD-1027-92 (DOE 1997). The ASA determined that, with reasonable controls, the EMWMF can be operated as a Radiological Facility.

Consistent with the methodology used to develop the facility categorization, an ASA-derived WAC has been derived for the various radionuclides that potentially could be accepted in the EMWMF. This WAC is applied using a sum-of-fractions approach that is separate and distinct from the analytic WAC SOFs. If the ASA-derived WAC SOF is less than one, the EMWMF can maintain its radiological facility categorization without having to alter the normal operating methodologies. If the ASA-derived WAC SOF is equal to or greater than one, then the waste placement operations will have to be altered using ASA-prescribed methods to accommodate the wastes.

1.4 PHYSICAL WAC

Physical WAC are derived from operational constraints and contractual agreements between DOE's Environmental Management prime contractor (hereafter referred to as the prime contractor), and the prime contractor's EMWMF operations subcontractor. Exceptions to physical WAC can be requested by RA subcontractors and obtained through negotiations between the RA subcontractor and the EMWMF operations subcontractor.

The generic WAC attainment process is depicted in the Fig. 4.

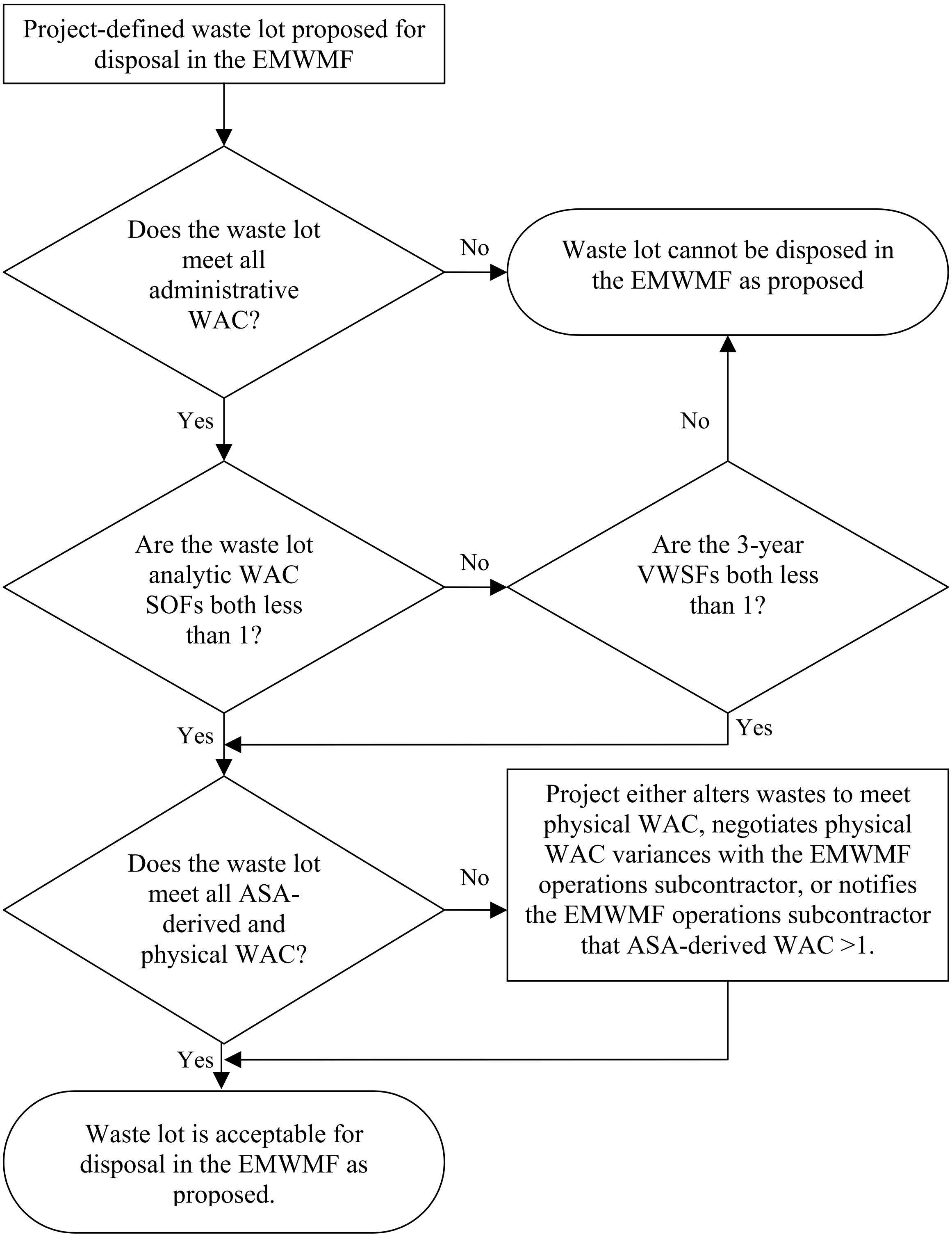


Fig. 4. Generic waste attainment process.

2. DEFINITIONS

Administrative WAC	Mandatory requirements for waste acceptance established in the EMWMF ROD or other agreements with regulatory agencies.
Analytic WAC	Numerical concentration of a constituent in a given waste lot such that, if the waste form with this concentration occupied the entire disposal cell volume, risk or HI to a public receptor would be equal to specified criteria.
Approve	Implementation of specific authority to make decisions.
ASA-derived WAC	Numerical concentration of a radioactive constituent in a given waste lot derived from the facility safety authorization basis such that, if the wastes remain below these concentrations, the categorization of the EMWMF as a Radiological Facility is preserved.
Certify	Attestation that the specific statements made about the contents or condition of the wastes are true to the best of the knowledge of the person or entity making the statements, and that there is sufficient data upon which to make the statements about those wastes.
Data	Process knowledge, anecdotal evidence, and analytical sample results used for the primary purpose of characterizing wastes to support WAC compliance determinations.
DQOs	Qualitative and quantitative statements derived from a process that clarifies and establishes a study's objectives, defines the appropriate type of data, and specifies the tolerable levels of potential decision errors that will be used to support decisions
FFA managers	The group of DOE, EPA, and TDEC mid-level managers responsible for adhering to the provisions of the FFA.
FFA parties	The DOE, EPA, and TDEC personnel assigned to oversee individual RA projects.
K_d	Solid-to-liquid equilibrium partition factor for a constituent. K_d are specific to the media being modeled; they are used to determine the leaching rate of constituents from wastes and the migration rate of leached contaminants through the wastes, the liner, and groundwater. A lower K_d will result in more contamination leaching from a waste and a faster migration rate. Different K_d can be used for leach rate calculations and for migration rates through various media.
Physical WAC	Physical limitations placed on waste forms. These limitations include grain size, dimensions, thickness, weight limitations, free liquid, compactability, double bagging of asbestos material, etc.

Site-related contaminants (SRCs)	Waste constituents with WAC concentration limits that exist at concentrations above site background concentrations with a 95% confidence and an 80% power, or whose rate of detection is below specified criteria. Note that a constituent does not have to be a contaminant of concern at the RA site to be an SRC for EMWMF WAC compliance purposes.
SOFs	Sum of the ratios of the concentrations of SRCs in a waste to their corresponding WAC concentration values. There are two separate SOFs for analytic WAC compliance, one for carcinogenic risk and one for toxicity HI. There are also separate SOF applications for ASA-derived WAC compliance based on the facility safety authorization basis, and for administrative WAC compliance based on TDEC waste classification regulations.
Verify	Examination of waste records to confirm they are complete and that there are no inconsistencies between the wastes and the descriptions in the waste records.
VWSF	Sum of all of the analytic WAC SOFs for each waste lot already placed and anticipated to be placed in the disposal cell, with each individual lot's SOF multiplied by the volume of the waste in that lot and then divided by the total volume of wastes for the period of interest. The total volume used to determine compliance for these calculations is the 3-year projected volume of waste plus the volume of material already in the EMWMF. Other volumes of interest may be used for planning purposes.
WAC Attainment Team	Team of prime contractor personnel tasked to evaluate waste lots independently to determine whether the wastes can be accepted for disposal in the EMWMF as proposed by the RA projects.
WACFACS	Waste Acceptance Criteria Forecasting Analysis Capability System. The Monte Carlo statistical analysis tool capable of calculating SOFs, VWSFs, and their uncertainties, and to run sensitivity analyses to determine the contaminants and waste lots driving those SOF, VWSF, and uncertainty results.
Waste anomaly	Wastes exhibiting different characteristics when generated than expected during initial characterization. Waste anomalies may be identified by visual differences from other wastes in a lot, unusual readings on safety and health monitoring instruments, in-situ measurements, or other means.
Waste lot	Primary unit of waste used to determine WAC compliance for disposal in the EMWMF and to track waste as it moves through the waste management system. The waste lot can include all of the wastes generated by an RA project or one of several subsets of those wastes. Waste lots are determined by the RA project to suit the needs of the RA and, generally, correspond to discrete actions within a project schedule. Other criteria to use for subdividing a waste stream into one or more waste lots could be material type, similarity of contaminants, or any

	other logical grouping that enhances the ability of the RA project to characterize and manage its wastes.
Waste package	A container together with its contents of waste in its final form for disposal, one or more of which may constitute a shipment. Examples of waste packages are a single box, a single drum, or the entire contents of a single bulk shipment.
Waste stream	All waste from a particular RA project destined for disposal in the EMWMF. Note that a waste stream may consist of one or more waste lots.

3. SCOPE AND PURPOSE

This WAC attainment plan has been developed to define the overall process for ensuring that all regulatory agreements and risk- and hazard-based performance criteria are attained during disposal operations. It also ensures the safe and efficient disposal of CERCLA waste in the EMWMF. The processes are constructed to do the following:

- analyze waste lots to determine concentrations and release parameters,
- determine VWSFs for current and future disposed waste,
- certify waste for on-site disposal or document why wastes could not be accepted,
- ensure all applicable LDRs are met,
- perform and document required quality assurance (QA)/quality control measures, and
- calculate WAC concentrations for new radionuclides or chemicals.

Specific waste management plans will be developed through the remedial design/remedial action process. For RA projects generating waste that will be disposed in the EMWMF, project-specific waste management plans will incorporate, or otherwise be consistent with, the requirements of this WAC attainment plan. Such plans will specify how a waste stream is divided into waste lots, any special considerations for individual waste lots, and waste characterization. It will also specify the management of anomalous wastes that may require segregation for additional characterization and separate consideration either for disposal in the EMWMF or for other disposition.

4. ROLES AND RESPONSIBILITIES

Several different entities must be integrated in order for the waste approval and disposal process to function properly. DOE is accountable for WAC compliance as described in this document. DOE has delegated the responsibility to make WAC attainment decisions to its prime contractor, which DOE oversees and audits. The WAC Attainment Team, composed of prime contractor personnel, is responsible for determining whether waste lots can be accepted for disposal. The prime contractor has in turn subcontracted the tasks of implementing RAs and operating the EMWMF, and has flowed its contract requirements down to its various subcontractors. EPA and TDEC oversee and audit RAs and EMWMF operations, including WAC Attainment Team decisions to authorize waste lots for disposal.

Within the prime contractor, there are several entities with WAC attainment responsibilities. Projects oversee RAs, Waste Operations oversees EMWMF operations, the WAC Attainment Team approves waste lots for disposal, and Planning and Controls provides strategic planning interfaces.

RA projects are responsible for complying with all WAC for wastes disposed in the EMWMF. RA projects will certify that their wastes meet all applicable administrative WAC or that appropriate waivers from administrative WAC have been obtained through their CERCLA documentation. RA projects will also certify that all reported analytic WAC parameters are correct. Finally, RA projects will certify that the parameters reported demonstrating compliance with the ASA-derived WAC concentrations are correct.

The EMWMF operations subcontractor is responsible for certifying that all physical WAC have been met. If wastes are found not to comply with any of the physical WAC, it will be the responsibility of the RA project generating those wastes to correct the noncompliant condition. The EMWMF operations subcontractor is also responsible for verifying that the wastes are from an approved waste lot and that all required RA project certifications have been made.

The WAC Attainment Team is responsible for approving all waste lots for disposal (see Sect. 5.5 for more information on the WAC Attainment Team). This approval requires that the 3-year VWSFs are ≤ 1 (see Sect. 5.2 for more details on VWSF calculations). If it is desired to dispose of a waste lot in the EMWMF when a 3-year VWSF is > 1, FFA Manager approval of this decision is required. The primary tool that will be used by the WAC Attainment Team to assess compliance with the 3-year VWSFs will be WACFACS (see Sect. 5 and Appendix D for more information on WACFACS). The WAC Attainment Team is responsible for maintaining and updating WACFACS and for performing all SOF and VWSF calculations used for approving waste lots. Other users may utilize WACFACS for planning purposes.

Table 1 presents a crosswalk of additional prime contractor, subcontractor, DOE, and regulator roles and responsibilities.

Table 1. Roles and responsibilities crosswalk

From: \ To:	RA project (prime contractor and RA subcontractor)	Prime contractor Waste Operations Project	EMWMF operations subcontractor	WAC Attainment Team	Prime contractor Planning and Controls	DOE	TDEC and EPA
RA project (prime contractor and RA subcontractor)	---	• Propose waste delivery schedule. • Inform if variance from physical WAC needed.	• Deliver wastes as scheduled. • Provide proper approval ID. • Inform if there are any delays.	• Provide required documentation for DQO Decisions 1, 2, and 3. • Identify anomalies.	• Provide LCB and WGF updates. • Provide any other requested data.	• Manage and execute RA scope. • Submit any required BCP changes.	• Adhere to all applicable regulations. • Propose any administrative WAC waivers.
Prime contractor Waste Operations Project	• Accept or negotiate waste delivery schedule. • Track approved variances to physical WAC.	---	• Integrate waste deliveries. • Enforce subcontract. • Track and enable any REAs.	• Propose any permanent changes to physical WAC.	• Report possible soil-to-debris ratio challenges. • Report project sequencing challenges.	• Provide interface with DOE. • Provide progress reports to DOE. • Respond to audit findings.	• Copy DOE progress reports to regulators. • Respond to audit findings.
EMWMF operations subcontractor	• Dispose wastes. • Verify physical WAC compliance.	• Record and track disposed volumes and locations. • Inform if REAs are required.	---	• Confirm wastes have proper approvals.	*	• Cooperate with audits.	• Cooperate with audits.
WAC Attainment Team	• Provide WAC attainment guidelines. • Approve wastes for disposal.	• Process any requested permanent changes to physical WAC for DOE consideration.	• Provide independent oversight of WAC compliance.	---	• Provide WACFACS VWSF results. • Perform VWSF scenario analyses.	• Report when waste lots are approved for disposal. • Maintain auditable VWSF system. • Notify of ASA-derived WAC variances. • Propose new and changed WAC.	• Copy waste lot approval decisions to regulators. • Maintain auditable VWSF. • Copy on ASA-derived WAC variances. • Support new WAC proposals
Prime contractor Planning and Controls	• Provide strategic sequencing of projects. • Examine projects for integration synergies.	• Explore solutions to soil-to-debris ratio and sequencing challenges.	*	• Analyze WACFACS VWSF results. • Request VWSF scenario analyses.	---	• Propose project-sequencing options to DOE. • Propose VWSF solutions.	• Support DOE solution proposals to regulators.
DOE	• Set RA scope. • Approve BCP changes.	• Audit and oversee disposal operations.	• Audit and oversee disposal activities.	• Audit and oversee WAC attainment decisions. • Consider proposed WAC changes.	• Consider and choose sequencing and VWSF solutions.	---	• Propose sequencing and VWSF solutions. • Propose new WAC and WAC changes.
TDEC and EPA	• Audit and oversee RA activities. • Approve any administrative WAC waivers.	• Audit and oversee disposal operations.	• Audit and oversee disposal activities.	• Audit and oversee WAC attainment and approval decisions.	*	• Concur with sequencing and VWSF solutions. • Approve new WAC and WAC changes.	---

*No direct interface

Table 1. Roles and responsibilities crosswalk (continued)

ASA = auditable safety analysis
BCP = baseline change proposal
DOE = U.S. Department of Energy
DQO = data quality objective
EMWMF = Environmental Management Waste Management Facility
EPA = U.S. Environmental Protection Agency
ID = identification
LCB = lifecycle baseline
RA = response action
REA = request for equitable adjustment
TDEC = Tennessee Department of Environment and Conservation
VWSF = volume-weighted sum of fractions
WAC = waste acceptance criteria
WACFACS = Waste Acceptance Criteria Forecasting Analysis Capability System
WGF = Waste Generation Forecast

5. WAC ATTAINMENT PROCESS

The overall WAC attainment process involves the completion of four separate sets of requirements. The first of these are the administrative WAC, which are derived from regulatory requirements and agreements. The second are the analytic WAC, which are derived from the CERCLA risk assessment modeling performed in support of the ROD remedial action objectives. The third are ASA-derived WAC, derived from the facility safety authorization basis. The last are physical WAC, which are derived from contractual agreements between DOE, its contractor, and the operations subcontractor. In order for wastes to be approved for disposal in the EMWMF, all four sets of requirements must be met.

Figure 4 illustrates the overall WAC attainment process. For each of the decisions, specific DQOs have been negotiated among DOE, EPA, and TDEC. These DQOs are described in detail in Appendix E and summarized in the following sections. Figure 5 depicts the agreed-upon DQO decisions for WAC compliance.

The primary unit of waste to be considered for WAC attainment is the waste lot. A waste lot can be all or some of the waste of a particular waste stream removed from a CERCLA site, from an entire waste stream down to a single truckload of waste, a set of drums of waste, or even a single drum of waste.

The size of individual waste lots will generally be determined by the extent to which the wastes are characterized and the similarity of the wastes across the site. If there are clear spatial variations in contaminant concentrations within the waste, several lots may be designated to distinguish waste with different contaminant loading. Also, even if a volume of waste does not have large variations in the contaminant concentrations, that waste may be divided into several lots for convenience in meshing the project's schedule with the production of its wastes. An example of this is a situation in which a project must excavate soils to a set cleanup standard. In such a case, a project may elect to declare the extent of the preliminary excavation one waste lot, and then create a separate waste lot for any additional excavation that is identified after obtaining any project-required RA verification samples.

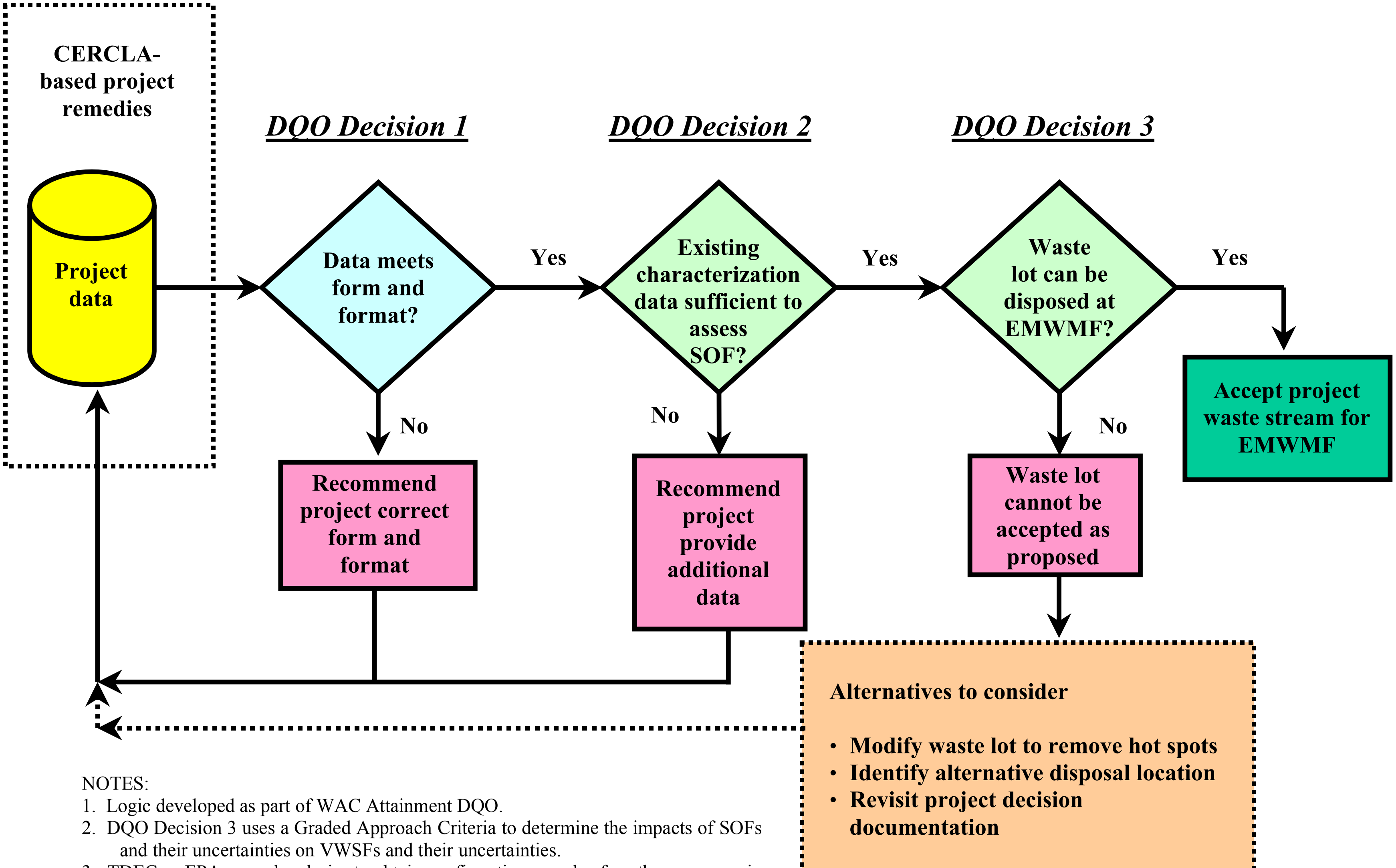
When potentially anomalous wastes are discovered while the action is being implemented, the waste anomaly must be characterized to ensure it fits within the predicted range of contamination concentrations for the approved waste lot. If so, it may be included with other wastes in that lot without further consideration. If not, the anomalous wastes must be segregated into a new waste lot and undergo separate analysis for disposal authorization, or for alternative disposition if it cannot meet the EMWMF WAC.

The justification and logic for determining the specific waste lots from a given waste stream should be included in the project's post-decision-document CERCLA documentation.

5.1 ADMINISTRATIVE WAC COMPLIANCE

Administrative WAC are derived from a variety of regulatory requirements and agreements and are presented in Table A.3. Typically, these requirements are derived from the EMWMF ROD (DOE 1999), either in the main body or in the ARARs tables. As such, compliance with administrative WAC is mandatory.

Several of the administrative WAC are derived from RCRA, TSCA, and low-level (radioactive) waste (LLW) regulations. Because the decision to build the EMWMF used the CERCLA process, only



NOTES:
1. Logic developed as part of WAC Attainment DQO.
2. DQO Decision 3 uses a Graded Approach Criteria to determine the impacts of SOFs and their uncertainties on VWSFs and their uncertainties.
3. TDEC or EPA may also desire to obtain confirmation samples for other purposes in DQO Decision 3.

Fig. 5. WAC DQO decisions.

the substantive portions of these ARARs apply. Therefore, the EMWMF is not a permitted landfill under any of these regulations and is authorized to accept only wastes generated as a result of CERCLA actions. However, since the EMWMF is a CERCLA cell accepting CERCLA waste, waivers of administrative WAC are possible on a case-by-case basis under CERCLA for individual waste streams. Should an RA project elect to seek such waivers, they must be included in the CERCLA documentation for the RA project and approved by the FFA parties for that project.

Most of the administrative WAC essentially form a checklist of requirements. Therefore, , the DQO for these WAC is tied to DQO Decision 1, which requires a 100% completion of all form and format requirements. However, one of the administrative WAC is derived from a commitment made to TDEC to ensure that the average total uranium concentration in the EMWMF is less than the total uranium WAC—1030 ppm—at DOE’s Fernald Plant waste disposal cell. This commitment was expanded to include a companion limit of 714 pCi/g total uranium, which is the activity of 1030 ppm natural uranium. Compliance with this administrative WAC is applied to the entire EMWMF instead of individual waste lots. In order to flow this requirement down to the project level, the average concentrations of in-cell materials will be tracked. The projections for individual projects used in WACFACS will be used along with the in-cell average concentration to calculate the projected average EMWMF concentration over a 3-year period. The process will confirm that the average uranium concentration meets this requirement upon closure of the EMWMF. The calculation of the average uranium concentration for administrative WAC compliance will be separate and distinct from the calculations performed for analytic WAC compliance.

Two additional elements of the administrative WAC require more detailed explanation: the short-lived radionuclide classification, and criticality safety.

5.1.1 Short-lived Radionuclide WAC

One of the administrative WAC specified in Table A.3 is derived from agreements with TDEC to use its LLW rules to guide acceptance of short-lived radionuclides. This process involves determination of the TDEC waste classification by comparing the concentrations of short-lived radionuclides to the limits found in TDEC 1200-2-11-.17(6). If a radioactive waste lot does not contain any of the radionuclides listed in the table, it is Class A. Otherwise, it is governed by the following rules:

- If the concentration does not exceed the value in Column 1, the waste is Class A.
- If the concentration exceeds the value in Column 1 but does not exceed the value in Column 2, the waste is Class B.
- If the concentration exceeds the value in Column 2 but does not exceed the value in Column 3, the waste is Class C.
- If the concentration exceeds the value in Column 3 the waste is classified as Greater-Than-Class-C and is not generally acceptable for near-surface disposal.
- For wastes containing mixtures of the nuclides listed in the table, the classification shall be determined by the SOF rule.

For the EMWMF, waste lots that are TDEC Class A, B, or C have been negotiated to be acceptable for disposal in the EMWMF. If application of these tabulated limits indicates a waste lot should be designated Greater-Than-Class-C, FFA manager approval is required for disposal of that waste lot.

5.1.2 Criticality Safety

The quantity of fissionable (fissile) material in a waste package shall be limited so that it remains subcritical during all phases of waste cell operations, including active waste disposal operations and inactive, post-closure periods. Where data indicate criticality may be a concern, associated information will be provided to FFA parties for review and comment. Concurrence of FFA parties is required where special conditions (e.g., treatment, encapsulation, special handling) is necessary for a waste to meet criticality safety criteria. A FFA Appendix I Operating Instruction shall be developed to address the concurrence process for criticality safety criteria. A CSE shall be performed for the following wastes:

- Waste packages having greater than 15 grams of ^{235}U that has an enrichment ≥ 0.90% by weight ^{235}U.

- Waste packages containing fissionable nuclides, other than enriched uranium, will be assigned on a case-by-case basis. Fissionable nuclides are listed in DOE Order 420.1, "Facility Safety," Table 4.3-1.

The CSE shall be performed in accordance with DOE Order 420.1, "Facility Safety," and applicable American National Standards Institute standards. DOE Standard STD-3007-93, Change Notice 1, "Guidelines for Preparing CSEs at Department of Energy Non-Reactor Nuclear Facilities," September 1998, is recommended as guidance for developing CSEs.

The CSE shall consider the actual materials in the waste and the accident condition in which the waste would be flooded with water. Preliminary calculations shall evaluate whether an infinite array of waste packages would remain subcritical given the following conditions:

- maximum reactivity of the fissionable material present is attained,

- the most reactive credible configuration consistent with the chemical and physical form of the material (e.g., lumped source, cylindrical, sphere, dispersed, etc.),

- moderation by water to the most reactive credible extent, and

- full reflection of the neutrons.

If preliminary calculations indicate a potential for criticality under these absolute worst-case conditions, calculations may consider more realistic conditions for the specific waste packages being evaluated. The CSEs shall clearly identify any worst-case assumption being modified and the basis for the modification. If the basis for modifying one of these assumptions relies upon operational restrictions by the EMWMF operations subcontractor, the RA subcontractor must demonstrate that the terms of the operational restriction have been negotiated with and accepted by the EMWMF operations subcontractor. Note that the EMWMF operations subcontractor may reject any proposed operational restrictions that, in the opinion of the operations subcontractor, can not be realistically performed. Any costs associated with enforcing operational restrictions must be negotiated between the RA project and the operations subcontractor, and any related costs shall be borne by the RA project.

5.2 ANALYTIC WAC COMPLIANCE

Analytic WAC prescribe limits on the concentrations of contaminants in the waste based on the risk and hazard criteria specified in the ROD (DOE 1999). Analytic WAC compliance is associated primarily with DQO Decisions 2 and 3. DQO Decision 2 is used to ensure that sufficient information is available to determine expected values and uncertainties of waste lot SOFs. SOFs are calculated conservatively using the soil analytic WAC for all waste forms (soillike, stabilized, solidified, debrislike, etc.) unless the FFA parties for the RA project seeking the variance concur with the use of waste-stream specific WAC concentrations that are calculated based on reduced leachability of the waste form relative to soil leachability. Such concurrence must be documented in the CERCLA documentation for the RA project. One specific case in which this may apply would be when waste-stream-specific measurements of K_d are available; these measurements would then be applied using the analytic WAC modeling process in Appendix B. In cases where treatment of radionuclides is used to justify an increased waste-stream-specific WAC, the treatment chosen must be demonstrated as being effective for the duration of the unacceptable hazard of the radionuclide as defined by the risk goals of the ROD.

All SRCs are used in this calculation, and a specific statistical goal of 95% confidence and 80% power (i.e., a 5% chance of a false negative and a 20% chance of a false positive) is assigned to decisions to eliminate waste constituents as SRCs. DQO Decision 3 is used to ensure that the VWSF is less than 1 using wastes already placed in the cell, the waste lot under consideration, and the projected wastes over the subsequent 3 years. VWSF calculations require a 90% confidence and a 90% power. If the VWSF cannot be adequately assessed as less than 1, waste lot data will be examined to determine which SRCs are driving SOF uncertainties. This analysis will be used to develop a graded approach to additional characterization needs beyond those required to address constituents with otherwise adequate data.

In cases where the VWSF marginally exceeds 1 using in-cell VWSFs, the waste lot SOFs, and the 3-year forecasted VWSF, it may still be desirable to dispose of that waste lot as proposed. In such cases, the WAC Attainment Team will propose a variance to DOE and, if DOE concurs, will seek a variance with the FFA managers. Only if the FFA managers concur can that waste lot be accepted as proposed.

The primary tool to ensure analytic WAC compliance is WACFACS, described in detail in Appendix D. WACFACS is a Monte Carlo statistical analysis program designed to calculate expected values and uncertainties of SOFs and VWSFs. It is through the application of this tool that compliance with DQO Decisions 2 and 3 will be demonstrated.

WACFACS uses a variety of input parameters to perform its calculations. Volume data are supplemented with a project determination of the relative confidence in the values reported in the Waste Generation Forecast (WGF). Project experts can assign high, moderate, or low confidence in the certainty of these volumes. Alternatively, if project knowledge indicates that the values in the WGF are actually representative of high-end or low-end estimates of expected volumes, WACFACS can accommodate this input as well.

Additionally, WACFACS requires not only estimates of expected average concentrations for each analytic WAC constituent, but also confidence intervals for those average values. The specific DQA techniques to be used for developing contaminant concentration input parameters for WACFACS is based on EPA guidance and is described in detail in Appendix C. The overall process starts with an assessment of what data is available and usable, including proxy values for qualified analytical data. Incomplete data for SRCs are noted as data gaps under DQO Decision 1. Next, the data are used to develop a list of SRCs, using the specific DQO goals of DQO Decision 2 for screening data against background concentrations or a frequency of detection screening process. Analytical data sets are then evaluated for the appropriate data distribution, and appropriate descriptive statistics are calculated for use by WACFACS. Finally, any data gaps that have been identified, including any additional data needs developed from the application of DQO Decision 3, are developed in sampling and analysis plans using guidance given in Appendix C.

VWSFs are calculated using three sets of information, shown in the Fig. 6. First are the actual volumes of in-cell material and their concentrations, including any suitable borrow material necessary for operational purposes. Second are the waste volumes from the WGF projected for the next 3 years, and concentrations provided by the projects within this time window. Other time periods of interest may be used for planning purposes, but only those within the 3-year window will be used to determine waste lot acceptability. Third are the volumes and concentrations of any waste lots under consideration for disposal. This third set of information is applicable only when a project is proposing one or more waste lots for approval to dispose in the EMWMF, and may contain updated volume estimates since the last WGF and updated concentrations (e.g., from any recent characterization efforts performed). As before, projections of waste lot volumes and SOFs used for waste lot approval are limited to a 3-year window, with other time periods of interest being used for planning purposes only. The WAC attainment concept of operations is depicted in Fig. 7.

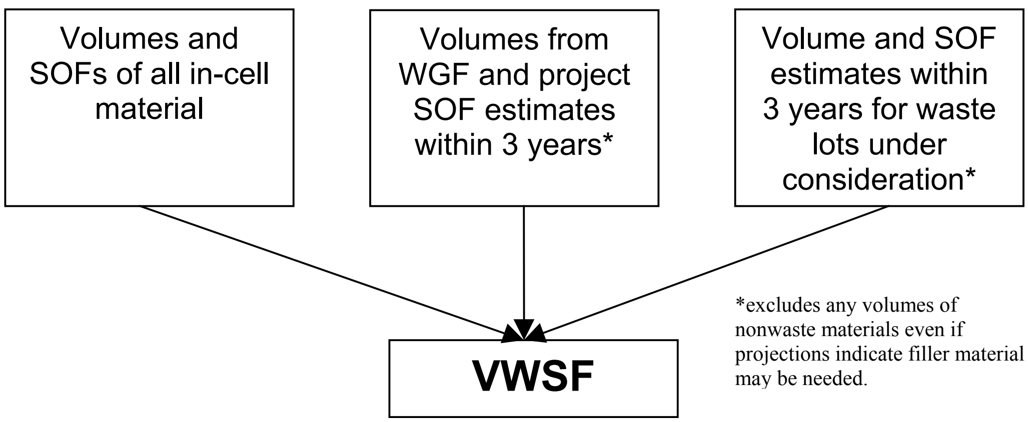


Fig. 6. VWSF calculation components.

It is important to note that suitable borrow materials shall not be included in the calculation of waste lot SOFs, even if projections of soil-to-debris ratios indicate void space filler may be needed. However, volumes of suitable borrow materials added to the EMWMF for operational purposes will be included in the calculation of VWSFs of in-cell material. Examples of operational uses of suitable borrow materials include operational covers for open work faces to mitigate possible wind-born releases, the planned intermediate soil layer for construction stability considerations, and use as void space filler material for structural stability when suitable waste materials are unavailable for this purpose. Waste materials will be used for void space filler whenever feasible.

The following sections describe the calculation of SOF and VWSFs in more detail.

5.2.1 SOF Calculations

None of the anticipated CERCLA waste contains only one contaminant; therefore, a method was developed to determine whether a waste containing multiple contaminants is acceptable for disposal. If the EMWMF is filled with a waste that contains two contaminants and if the concentration of each

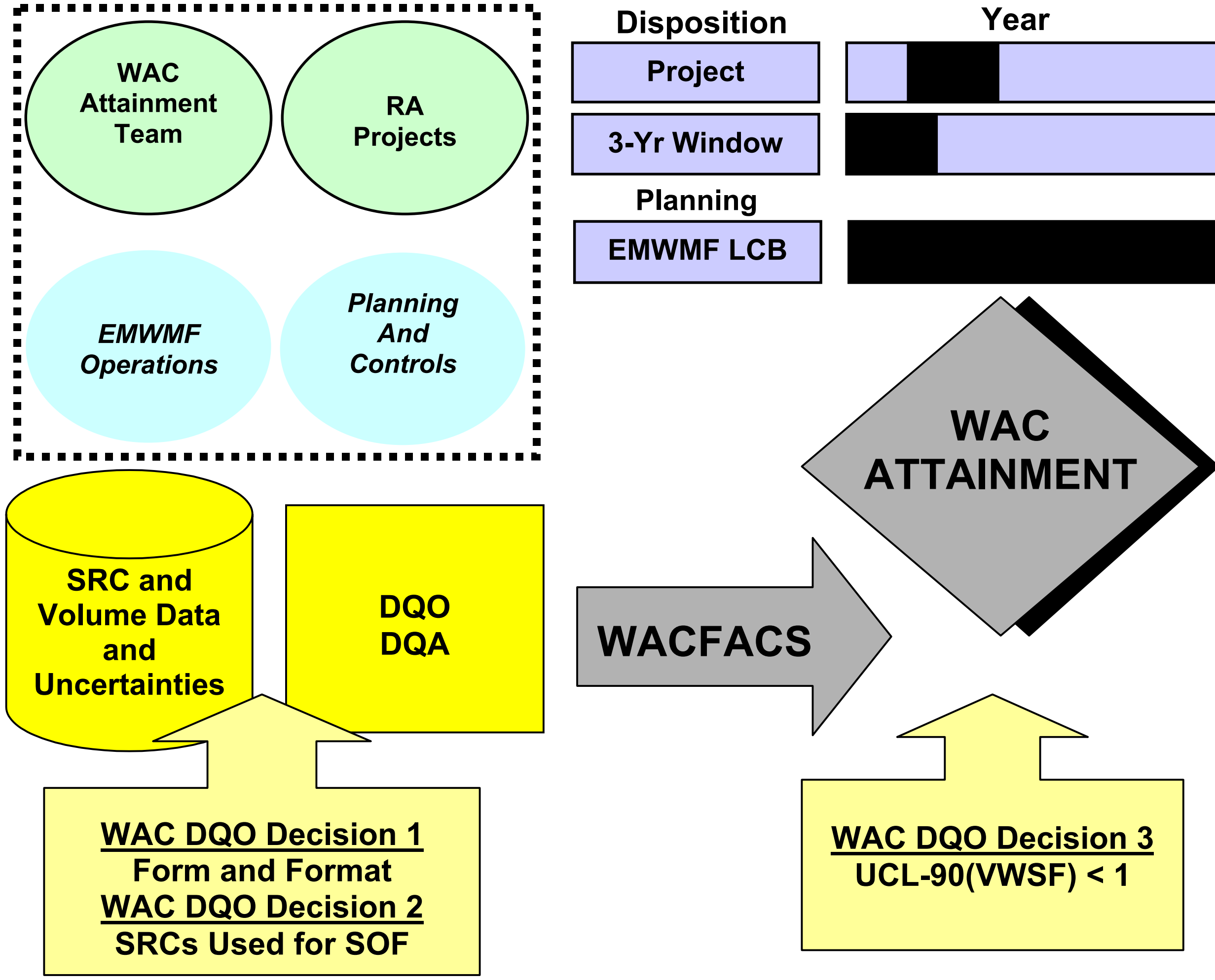


Fig. 7. WAC attainment concept of operations.

contaminant is at the level of its WAC, then the resultant risk will be twice that prescribed by the risk criteria. Because the risks must not be allowed to exceed the criteria, both of the contaminant concentrations in the waste should be less than their respective WAC if the waste is to be acceptable for placement in the facility. For example, if the concentration of Contaminant A is at 60% of its WAC and the concentration of Contaminant B is at 40%, then the waste is acceptable for placement in the facility. Similarly, if three contaminants are present in the waste and one is at 10% of its WAC, a second is at 50%, and the third is at 40%, then the waste is acceptable.

Therefore, the general rule for evaluating waste containing multiple contaminants is to sum the ratios of the concentrations of the contaminants present to corresponding WAC concentration limits. This is called the SOF rule for evaluating which wastes can be placed in the facility. The SOF calculation is applied for all the various waste lots using the set of analytic WAC appropriate for the SRCs present. In mathematical form, the SOF is as follows:

$$SOF = \sum_i \frac{C_i}{WAC_i}$$

where:

C_i = the average concentration of contaminant i,
WAC_i = the analytic WAC for contaminant i.

SOFs are calculated for all SRCs that have analytic WAC limits. The decision logic used to determine SRCs is detailed in Appendix C. If a project has screened out a constituent with an analytic WAC limit as not being an SRC, that constituent is not included in SOF calculations. Consistent with EPA regulations, if a waste has been properly treated with RCRA-prescribed best available technology or best demonstrated available technology, the effects of that treatment is presumed to be effective for controlling future risks from the treated contaminants after the wastes are placed in the RCRA-compliant EMWMF. Therefore, the treated contaminants will be excluded from SOF calculations.

5.2.2 VWSF Calculations

Note that the preceding discussion of SOF calculations is specific to a single waste lot. Many waste lots from many different sources will be placed at the EMWMF. If the SOFs for a few of those lots are significantly less than 1, it should be possible to put other waste lots with SOFs greater than 1 in the waste cell and still meet the risk criteria. For example, consider two waste lots of equal volume. If one has a carcinogenic SOF of 0.9 and the other has a carcinogenic SOF of 1.1, both could be placed in the cell and the net SOF for the combination would be 1. Therefore, for this example the carcinogenic risk criteria would be met.

When the waste lots have different volumes, the method for maximizing the amount of waste that can be put in the cell without the projected risk from the waste exceeding the criteria becomes more complex, but not intractable. A VWSF can be calculated to account for the fact that not all waste lots will contain the same volume of waste. The VWSF is the sum of all of the SOFs for each waste lot placed, or anticipated to be placed, in the disposal cell, with each individual lot's SOF multiplied by the volume of the waste in that lot and then divided by the total projected volume of waste. If the VWSF for waste volumes projected to be placed over a three-year period is ≤ 1, the waste to be placed in the cell meets the criteria. Note that, since the WAC concentrations were originally derived assuming the entire cell volume was filled, other time periods or volumes of interest may be used for planning purposes. In mathematical form, the VWSF is as follows:

$$VWSF = \frac{1}{V_{tot}} \sum_j SOF_j V_j$$

where

SOF_j = the sum of fractions for waste lot j,
V_j = the volume of waste lot j,
V_{tot} = the total of in-cell volumes and the 3-year projection from the WGF of waste volumes to be placed in the EMWMF (other time frames can be used for planning purposes)

5.3 ASA-DERIVED CONCENTRATION LIMITS

The EMWMF is categorized as a Radiological Facility. An ASA has been prepared detailing how this facility categorization will be maintained during operations. In general, the ASA determined that the maximum credible release of material would occur during an extreme wind event. The erosion of 1 cm of unprotected open waste was assumed. For EMWMF operations, an open face of approximately 300 m^2 is planned during normal operations, yielding a calculated 4.05×10^7 g of material released during this event. When used in conjunction with Nuclear Category 3 Threshold Quantities found in DOE STD-1027-92 Change Notice 1 (September 1997), "Hazard Categorization and Accident Analysis Techniques for Compliance With DOE Order 5480.23, Nuclear Safety Analysis Reports," this release quantity can be used to calculate concentration limits for all radionuclides disposed in the EMWMF. These limits are presented in Table A.2.

DOE STD-1027-92 prescribes the use of an SOF approach to determine facility categorizations when more than one radionuclide is present. As such, the ASA-derived limits must also be applied using an SOF approach. Specifically, when the SOFs of radionuclide concentrations to their ASA-derived WAC is less than 1, the wastes can be accepted without further consideration of this WAC requirement. When the SOF exceeds 1, operations must be altered to accommodate these wastes. It is important to note, however, that this WAC SOF is distinct and separate from analytic WAC SOF, and the two calculations have no bearing on each other.

In cases where the ASA-derived WAC SOF exceeds 1, the EMWMF operations subcontractor must be contacted to make special arrangements for handling these wastes. Also, DOE and the regulators will be notified of the agreed methods that will be used to accommodate such wastes.

Since the ASA-derived WAC calculations are safety-based determinations that will involve distinct subsets of waste lots (as opposed to analytic WAC limits, which are based on the entire EMWMF volume), the 95% upper confidence limit (UCL_{95}) of SRC concentrations of radionuclides shall be used for ASA-derived WAC SOFs. In cases where the UCL_{95} concentration exceeds the maximum detected concentration, the maximum detected concentration of the SRC can be used instead.

Like administrative WAC, the calculation of the ASA-derived WAC SOF is essentially a checklist requirement. As such, the DQO for this WAC is also tied to DQO Decision 1, which requires a 100% completion of all form and format requirements.

5.4 PHYSICAL WAC

Physical WAC describe the physical parameters that guide whether wastes can be accepted for disposal, require additional processing for acceptance, or require that variances be sought. These physical parameters include weight, size, and waste form restrictions. In general, variances to physical WAC are acceptable as long as the integrity of the cell liner and cover can be ensured and environmental, health, and safety considerations are not compromised.

Like administrative and ASA-derived WAC, physical WAC essentially form a checklist of requirements. As such, the DQO for these WAC is also tied to DQO Decision 1, which requires a 100% completion of all form and format requirements. Table A.4 presents the physical WAC.

5.5 WAC ATTAINMENT TEAM OPERATIONS

The WAC Attainment Team will be the prime contractor entity responsible for approving or disapproving waste lots for disposal in the EMWMF. To accomplish this mission, a variety of tools and information will be used. WAC Attainment Team decisions include accepting the waste lot for disposal, recommending to projects that the waste lot be altered (e.g., by segregating out hot spots for separate disposition), or requiring additional data in order to make a decision. The WAC Attainment Team decision logic is depicted in Fig. 8.

In order to accomplish its mission, the WAC Attainment Team will work with the RA projects early in the WAC attainment process. Though it will by necessity remain independent of the projects, the team will provide technical assistance to the RA projects to communicate its expectations of requirements. One important aspect of this technical assistance will be the calculation of project SOFs and their uncertainties, and the assessment of the impact of these SOFs on the VWSFs. The demonstration of WAC attainment will remain an RA project responsibility, but the WAC Attainment Team will be accountable for calculation of SOF and VWSF results.

In order to fulfill these duties, the WAC Attainment Team is made up of a variety of personnel bringing key skills to the team geared toward fulfilling the key WAC DQO decisions necessary for WAC attainment compliance. Figure 9 depicts these key skill areas. Not all skill areas will require a full-time team member, and one individual may provide expertise in more than one skill area. In general, the number and mix of permanent team personnel will be based upon the number and type of projects seeking disposal approval at any given time, with additional team members being added on a temporary or permanent basis as the work load or decision complexity dictates.

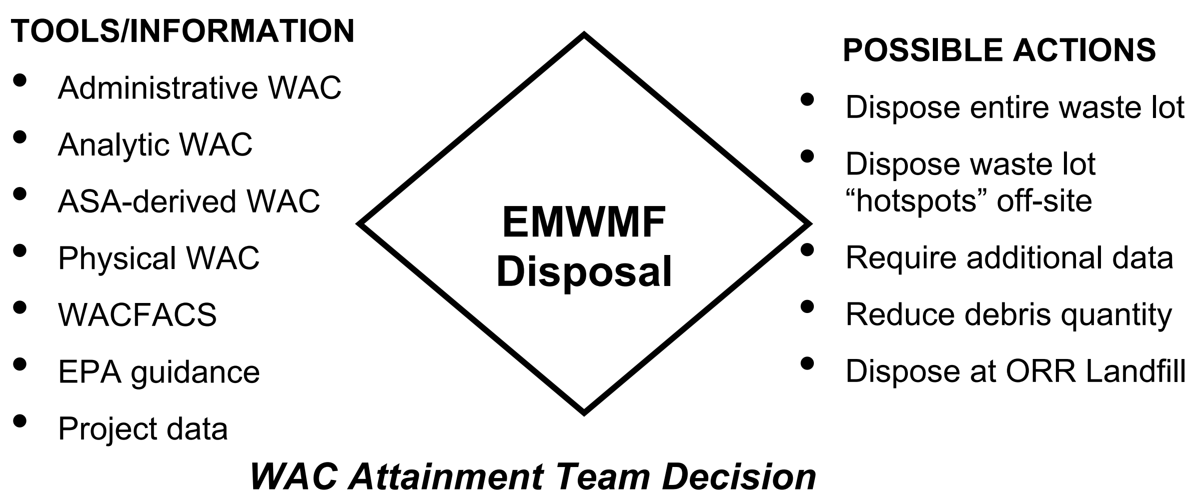


Fig. 8. WAC Attainment Team decision elements.

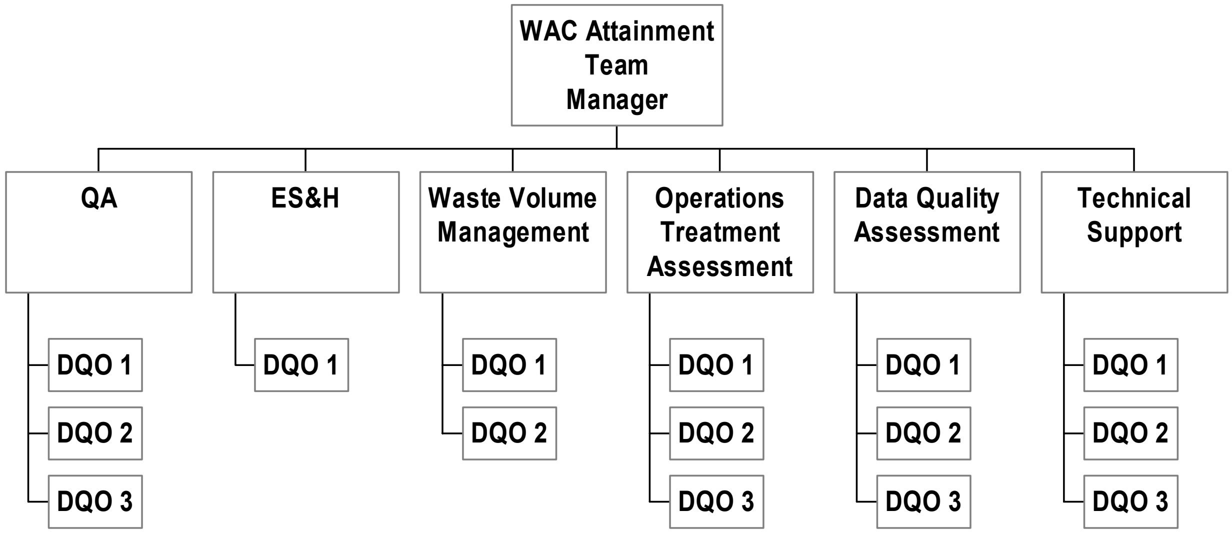


Fig. 9. WAC Attainment Team organization.

The overall EMWMF WAC Attainment Team waste approval process will generally follow a pattern whereby the projects submit waste profile information for initial assessment, followed by closure of any remaining open issues. If no data gaps exist, approval can be granted if all WAC requirements are met. If data gaps exist, additional data must be gathered prior to evaluating final approval. Once approved, RA projects will screen the wastes for anomalies while they are generated. If no changed conditions are encountered while wastes are generated, they can be shipped for disposal. Otherwise, anomalies must be segregated for separate characterization and approval. Figure 10 outlines this process.

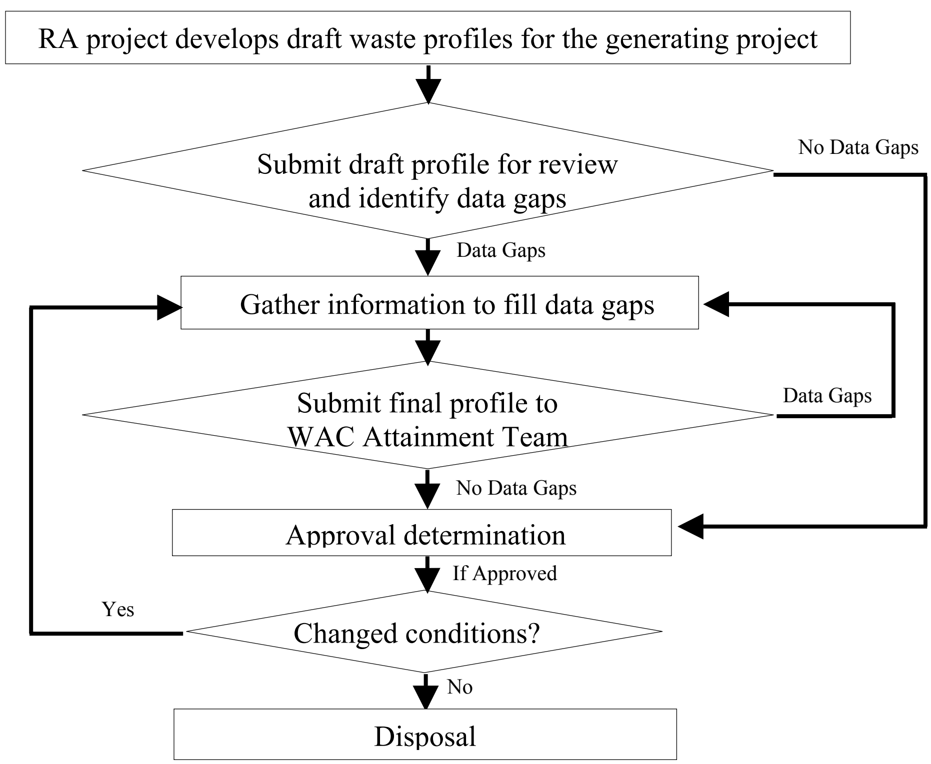


Fig. 10. EMWMF WAC Attainment Team waste approval process.

Each RA project disposing wastes in the EMWMF will undergo a readiness evaluation prior to generating wastes. This evaluation will ensure that all logistics, systems, and information necessary for the successful disposal of the wastes are in place and understood. The WAC Attainment Team will be represented at each RA project's readiness evaluation to ascertain the completeness of the DQO decisions and to verify that all WAC compliance questions have been answered.

6. RECORD KEEPING

Several records will support the WAC attainment process. The records may have other uses as well, but their presence in the operating facility files will be necessary to document the process. The specific forms of the records and the procedures for their completion will be prescribed in implementing procedures.

Records documenting the attainment of the WAC will revolve around the waste lot. The waste lot is the primary indicator by which waste can be identified in the database.

Shipments from waste lots will be tracked "cradle to grave." That is, each shipment will have a separate record from the time it is generated (usually when it is removed from its original location at the CERCLA site) to its placement in the EMWMF. If waste lots are mixed during disposal in the EMWMF (for example, if contaminated soil is used as bedding for debris waste), that mixing will appear implicitly in the operating facility records because both waste lots will be shown to have been disposed in the same location.

Waste shipment records will at a minimum contain the following information:

- the waste lot from which the shipment came and a sequential numbering of each shipment,
- the volume of the waste being shipped in the conveyance,
- the average and UCL_{95} SRC concentrations assigned to the waste lot,
- the ASA-derived WAC SOF for the waste lot, and
- date and time the wastes left the CERCLA site.

Once the EMWMF operations subcontractor receives the waste shipment, additional information will be added to the waste shipment documentation, including, but not limited to, the following:

- date and time the wastes were received at the EMWMF,
- confirmation that the waste lot number is on the list of WAC Attainment Team approved waste lots,
- confirmation that physical WAC requirements were met, and
- identification of where the shipment was placed in the EMWMF.

7. QUALITY ASSURANCE

RA project subcontractor QA plans will establish and provide specific QA procedures and associated documentation requirements for all project-specific aspects of the WAC attainment process, including the following:

- waste characterization bases, including process knowledge, existing analytical data, and the results of any sampling and analysis performed;

- Toxicity Characteristic Leaching Procedure testing and other requiring testing and treatment for LDR compliance, if required; and

- field observation logs documenting waste generation activities, including actions taken to address any anomalies found.

The quality of waste approval decisions is also guaranteed by adherence to this WAC attainment plan and the use of regulator-approved guidance documents to supplement this plan. Examples of such regulatory guides are the DQO and DQA guidance documents, and EPA's Risk Assessment Guidance for Superfund (EPA 1989). A listing of the references used to develop this WAC attainment plan and its appendices is given in Chap. 8, along with a listing of referenced guidance documents for project use.

In addition, the prime contractor will prepare auditable records of its QA activities. Such prime contractor QA activities will include project oversight observations and auditing of waste generation activities, the WAC Attainment Team's independent approval of waste lots for disposal, and any prime contractor Performance/Quality Assurance Group independent internal audits of prime contractor and subcontractor activities.

Whenever DOE or regulatory agency oversight observations are submitted, either as less formal day-to-day interactions or more formal audits, these observations will be formally tracked to closure.

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APPENDIX A

FINAL WASTE ACCEPTANCE CRITERIA

Table A.1. Soil waste form WAC for resident farmer using a well for domestic water supply and Bear Creek for agricultural water supply

Radionuclides*/**	HI WAC*** (pCi/g)	Carcinogenic WAC*** (pCi/g)
^{227}Ac		
^{108m}Ag		
^{26}Al		
^{241}Am		*2.0E+21*
^{243}Am		
^{133}Ba		
^{207}Bi		
^{14}C		*165*
^{249}Cf		
^{250}Cf		
^{251}Cf		
^{36}Cl		
^{60}Co		
^{242}Cm		
^{243}Cm		
^{244}Cm		
^{245}Cm		
^{246}Cm		
^{247}Cm		
^{248}Cm		
^{135}Cs		
^{137}Cs		
^{150}Eu		
^{152}Eu		
^{154}Eu		
^{155}Eu		
^{129}I		*13*
^{40}K		

Table A.1. Soil waste form WAC for resident farmer using a well for domestic water supply and Bear Creek for agricultural water supply (continued)

Radionuclides*/**	HI WAC*** (pCi/g)	Carcinogenic WAC*** (pCi/g)
^{93m}Nb		
^{59}Ni		
^{63}Ni		
^{237}Np		*320*
^{231}Pa		
^{210}Pb		
^{107}Pd		
^{236}Pu		
^{238}Pu		
^{239}Pu		*720*
^{240}Pu		*5800*
^{241}Pu		
^{242}Pu		
^{244}Pu		
^{226}Ra		
^{228}Ra		
^{79}Se		
^{32}Si		
^{151}Sm		
^{121m}Sn		
^{126}Sn		
^{90}Sr		
^{99}Tc		*172*
^{228}Th		
^{229}Th		
^{230}Th		
^{232}Th		
^{3}H		*1.5E+05*
^{232}U		

Table A.1. Soil waste form WAC for resident farmer using a well for domestic water supply and Bear Creek for agricultural water supply (continued)

Radionuclides*/**	HI WAC*** (pCi/g)	Carcinogenic WAC*** (pCi/g)
^{233}U	*4.5E+07*	*1700*
^{234}U	*2.8E+07*	*1700*
^{235}U	*9500*	*1500*
^{236}U	*2.8E+05*	*1700*
^{238}U	*1500*	*1200*
^{93}Zr		
Chemicals*	***HI WAC**** (mg/kg)**	***Carcinogenic WAC**** (mg/kg)**
Aluminum		
Antimony	*160*	
Arsenic		
Barium	*1.5E+05*	
Beryllium		
Cadmium		
Chromium (total)	*1.4E+05*	
Cobalt		
Lead	*1500*	
Manganese		
Mercury		
Nickel		
Selenium	*1600*	
Silver		
Strontium	*3.0E+05*	
Thallium		
Tin	*2200*	
Vanadium	*2.5E+04*	
Zinc		
Zirconium		
1,1,1-Trichloroethane		
1,1,2-Trichloro-1,2,2-Trifluoroethane		
1,1,2-Trichloroethane		

Table A.1. Soil waste form WAC for resident farmer using a well for domestic water supply and Bear Creek for agricultural water supply (continued)

Chemicals*	***HI WAC***** **(mg/kg)**	***Carcinogenic WAC***** **(mg/kg)**
1,1-Dichloroethane		
1,2-Dichloroethane		
1,1-Dichloroethene (Dichloroethylene)		
1,2-Dichloroethene		
2,4,5-Trichlorophenol		
2,4-Dinitrophenol		
2-Butanone		
2-Chlorophenol		
2-Chloronaphthalene		
2-Nitroaniline (O - Nitroaniline) (P - Nitroaniline)		
3,3'-Dichlorobenzidine		
4,6-Dinitro-2-methylphenol		
Acenaphthene	*3.9E+05*	
Acetone	*270*	
Anthracene		
Aroclor-1242		
Aroclor-1248		
Aroclor-1254		
Aroclor-1260		
Benzene		*200*
Benzo(a)anthracene		
Benzo(a)pyrene		
Benzo(b)fluoranthene		
Benzo(k)fluoranthene		
bis(2-Ethylhexyl)phthalate		
Butylbenzylphthalate		
Carbazole		*1.1E+05*
Carbon tetrachloride	*66*	*56*
Chloroform	*100*	*40*
Chrysene		

Table A.1. Soil waste form WAC for resident farmer using a well for domestic water supply and Bear Creek for agricultural water supply (continued)

Chemicals*	***HI WAC****** **(mg/kg)**	***Carcinogenic WAC****** **(mg/kg)**
Di-n-butylphthalate	*190*	
Dibenzo(a,h)anthracene		
Dieldrin	*60*	*7.1*
Fluoranthene		
Fluorene		
Indeno(1,2,3-cd)pyrene		
Isophorone	*1.5E+04*	*6100*
N-nitroso-di-n-propylamine		*0.019*
Naphthalene	*9900*	
Pentachlorophenol		
Phenanthrene		
Phenol	*3200*	
Pyrene		
Tetrachloroethene	*2900*	*440*
Toluene	*4.9E+04*	
Trichloroethene		*780*

* Other administrative WAC compliance considerations may apply in addition to analytic WAC considerations, such as transuranic waste limits or RCRA LDRs. See Sect. 5.1 and Table A.3 for further details.

** Concentration limits based on compliance with the EMWMF ASA also apply to radionuclides. See Sect. 5.3 and Table A.2 for further details.

*** Where WAC is not given for either the HI or cancer criteria, contaminant migration was nevertheless modeled and contamination either does not reach the receptor in 100,000 years or radioactively decays to an insignificant level before reaching the receptor. In such cases the contaminant does not have a complete pathway, and its concentration does not affect the SOF or VWSF calculations.

Ac = actinium
Ag = silver
Al = aluminum
Am = americium
ASA = auditable safety analysis
Ba = barium
Bi = bismuth
C = carbon
Cf = californium
Cl = chlorine
Cm = curium
Co = cobalt
Cs = cesium
EMWMF = Environmental Management Waste Management Facility
Eu = europium
g = gram
^{3}H = tritium
HI = hazard index
I = iodine
K = potassium
kg = kilogram
LDR = land disposal restriction
mg = milligram
Nb = niobium
Ni = nickel
Np = neptunium
Pa = protactinium
Pb = lead
pCi = picocurie
Pd = palladium
Pu = plutonium
Ra = radium
RCRA = Resource Conservation and Recovery Act of 1976
Se = selenium
Si = silicon
Sm = samarium
Sn = tin
SOF = sum of fractions
Sr = strontium
Tc = technetium
Th = thorium
U = uranium
VWSF = volume-weighted sum of fractions
WAC = waste acceptance criteria
Zr = zirconium

Table A.2. ASA-derived WAC

Radionuclide	ASA-derived WAC* (pCi/g)	Category 3 threshold quantity (Ci)	Radionuclide	ASA-derived WAC* (pCi/g)	Category 3 threshold quantity (Ci)
^{227}Ac	1.0E+03	4.20E-02	Ni-63	1.3E+08	5.40E+03
^{108m}Ag	4.9E+06	2.00E+02	Np-237**,***	1.0E+04	4.20E-01
^{26}Al	5.9E+06	2.40E+02	Pa-231	4.9E+03	2.00E-01
^{241}Am**,***	1.3E+04	5.20E-01	Pb-210	8.9E+03	3.60E-01
^{243}Am***	1.3E+04	5.20E-01	Pd-107	1.0E+08	4.20E+03
^{133}Ba	2.7E+07	1.10E+03	Pu-236	4.9E+04	2.00E+00
^{207}Bi	1.2E+07	5.00E+02	Pu-238***	1.5E+04	6.20E-01
^{14}C**	1.0E+07	4.20E+02	Pu-239**,***	1.3E+04	5.20E-01
^{113m}Cd	2.9E+05	1.18E+01	Pu-240**,***	1.3E+04	5.20E-01
^{249}Cf***	1.3E+04	5.20E-01	Pu-241	7.9E+05	3.20E+01
^{250}Cf	2.6E+04	1.04E+00	Pu-242***	1.5E+04	6.20E-01
^{251}Cf***	1.3E+04	5.20E-01	Pu-244***	1.5E+04	6.20E-01
^{36}Cl	8.4E+06	3.40E+02	Ra-226	3.0E+05	1.20E+01
^{242}Cm	7.9E+05	3.20E+01	Ra-228	3.0E+05	1.20E+01
^{243}Cm***	2.0E+04	8.20E-01	Se-79	8.9E+06	3.60E+02
^{244}Cm	2.6E+04	1.04E+00	Si-32	1.3E+06	5.20E+01
^{245}Cm***	1.3E+04	5.20E-01	Sm-151	2.5E+07	1.00E+03
^{246}Cm***	1.3E+04	5.20E-01	Sn-121m	4.4E+07	1.78E+03
^{247}Cm***	1.5E+04	6.20E-01	Sn-126	4.2E+06	1.70E+02
^{248}Cm***	2.6E+03	1.04E-01	Sr-90	4.0E+05	1.60E+01
^{60}Co	6.9E+06	2.80E+02	Tc-99**	4.2E+07	1.70E+03
^{135}Cs	1.0E+07	4.20E+02	Th-228	2.5E+04	1.00E+00
^{137}Cs	1.5E+06	6.00E+01	Th-229	2.3E+03	9.40E-02
^{150}Eu	9.9E+08	4.00E+04	Th-230	1.5E+04	6.20E-01
^{152}Eu	4.9E+06	2.00E+02	Th-232	2.5E+03	1.00E-01
^{154}Eu	4.9E+06	2.00E+02	U-232	2.0E+04	8.20E-01
^{155}Eu	2.3E+07	9.40E+02	U-233**	1.0E+05	4.20E+00
^{3}H**	4.0E+08	1.60E+04	U-234**	1.0E+05	4.20E+00
^{129}I**	1.5E+03	6.00E-02	U-235**	1.0E+05	4.20E+00
^{40}K	4.2E+06	1.70E+02	U-236**	1.0E+05	4.20E+00
^{93m}Nb	4.9E+07	2.00E+03	U-238**	1.0E+05	4.20E+00
^{59}Ni	2.9E+08	1.18E+04	Zr-93	1.5E+06	6.20E+01

*The EMWMF ASA assumed a release of 4.05×10^7 g of material during a high wind event.

**Radionuclide also has analytic WAC restrictions.

***Radionuclide also is limited by the administrative WAC prohibiting transuranic waste (i.e., greater than 100 nCi/g of alpha-emitting transuranic radionuclides with half-lives greater than 20 years).

ASA = auditable safety analysis
EMWMF = Environmental Management Waste Management Facility
WAC = waste acceptance criteria

Table A.3. Administrative WAC

Criteria	Basis	Notes
Wastes must be generated as part of a CERCLA action on the ORR or at sites within the State of Tennessee where contamination can be directly related to ORR releases.	EMWMF ROD	
No transuranic waste, high-level waste, spent nuclear fuel, or 11e (2) byproduct waste	EMWMF ROD	Radioactive wastes must meet the low-level waste definitions
No free liquids	1. RCRA ARAR requires wastes to pass the paint filter test. Liner protection and waste compatibility are the primary drivers	1. RCRA hazardous wastes would have to receive a valid RCRA waiver, be demonstrated to be compatible with other wastes in cell, and be compatible with the liner system. It is anticipated that exemptions would not be feasible
	2. LLW ARAR requires wastes to have < 1% by volume free liquids. Minimization of leachate production is of primary concern	2. LLW without a RCRA or TSCA component would have to demonstrate < 1% by volume of nonhazardous free liquids. It is anticipated that most wastes will have insignificant amounts of free liquids.
Must meet RCRA and TSCA land disposal restrictions	RCRA and TSCA ARARs	
No infectious wastes	LLW and RCRA ARARs	
No pyrophoric materials	LLW ARAR	
Must not be capable of detonation or of explosive decomposition or reaction at normal pressures and temperatures or of explosive reaction with water	LLW ARAR	
Must not contain or be capable of generating quantities of toxic gases, vapor, or fumes	LLW ARAR	
Must have structural stability either by processing the waste or placing the waste in a container or structure that provides stability after disposal	LLW ARAR	
Void space within the waste and between the waste and its package must be reduced to the extent practicable	LLW ARAR	The EMWMF operations subcontractor will have the capability to crush containers with a D8 Caterpillar bulldozer. Any other methods needed to fulfill this administrative WAC will have to be arranged by the RA subcontractor.
Unless they are very small, containers must be either at least 90% full when placed in the landfill or crushed, shredded, or similarly reduced in volume to the maximum practical extent before burial in the landfill	RCRA ARAR	
Average total uranium concentrations in the EMWMF must be less than 1030 ppm or 714 pCi/g, whichever is more restrictive.	DOE Orders, and DOE- and TDEC- negotiated agreement	Limits apply to expected values of total uranium and are separate from and in addition to analytic WAC considerations.
Waste packages shall be limited so that they will remain subcritical during all phases of waste cell operations, including active waste disposal operations and inactive, post-closure periods.	DOE Orders, and DOE- and TDEC- negotiated agreement	
Wastes shall not exceed Class C limits prescribed within Tennessee low-level waste regulations [TN 1200-2-11-.17(6)].	TDEC negotiated agreement	

`Table A.3. Administrative WAC (continued)

Tennessee LLW classification of long-lived radionuclides for administrative WAC compliance[a]		
Radionuclide	*Ci/m³*	*pCi/g (assuming 1.7 g/cc)*
^{14}C	*8*	*4.7×10^6*
^{14}C in activated metal	*80*	*4.7×10^7*
^{59}Ni in activated metal	*220*	*1.3×10^8*
^{94}Nb in activated metal	*0.2*	*1.2×10^5*
^{99}Tc	*3*	*1.8×10^6*
^{129}I	*0.08*	*4.7×10^4*
Alpha emitting transuranic nuclides with half-lives greater than five (5) years	*100 nCi/g*	*1.0×10^5*
^{241}Pu	*3,500 nCi/g*	*3.5×10^6*
^{242}Cm	*20,000 nCi/g*	*2.0×10^7*

Tennessee LLW classification of short-lived radionuclides for administrative WAC compliance[a]

Radionuclide	*Column 1 (Class A limits)*		*Column 2 (Class B limits)*		*Column 3 (Class C limits)*	
	Ci/m³	*pCi/g (assuming 1.7 g/cc)*	*Ci/m³*	*pCi/g (assuming 1.7 g/cc)*	*Ci/m³*	*pCi/g (assuming 1.7 g/cc)*
Total of all nuclides with < 5-year half-life	*700*	*4.1×10^8*	*([1])*	*([1])*	*([1])*	*([1])*
^{3}H	*40*	*2.4×10^7*	*([1])*	*([1])*	*([1])*	*([1])*
^{60}Co	*700*	*4.1×10^8*	*([1])*	*([1])*	*([1])*	*([1])*
^{63}Ni	*3.5*	*2.1×10^6*	*70*	*4.1×10^7*	*700*	*4.1×10^8*
^{63}Ni in activated metal	*3.5*	*2.4×10^7*	*700*	*4.1×10^8*	*7000*	*4.1×10^9*
^{90}Sr	*0.04*	*2.4×10^4*	*150*	*8.8×10^7*	*7000*	*4.1×10^9*
^{137}Cs	*1*	*5.9×10^5*	*44*	*2.6×10^7*	*4600*	*2.7×10^9*

([1]) There are no limits established for these radionuclides in Class B or C wastes. Practical considerations, such as the effects of external radiation and internal heat generation on transportation, handling, and disposal, will limit the concentrations for these wastes. These wastes shall be Class B unless the concentrations of ^{63}Ni, ^{90}Sr, and ^{137}Cs determine the waste to be Class C.

[a] Adopted from Tennessee LLW regulations [TN 1200-2-11-.17(6)]. Basically, concentration limits are applied using the SOF of radionuclide concentrations divided by the WAC concentrations. If the SOF for long-lived radionuclides is less than or equal to 0.1, it is designated as Class A for long-lived radionuclides. If the SOF for long-lived radionuclides exceeds 0.1, the wastes are Class C. If the long-lived radionuclide SOF exceeds one, the wastes are designated as GTCC. A separate SOF is then performed for short-lived radionuclides. If the SOF exceeds unity (1) for Class A, but is less than unity for Class B, the wastes are designated as Class B for short-lived radionuclides. If it exceeds unity for Class B but is less than unity for Class C, the wastes are designated as Class C. If it exceeds unity for Class C, the wastes are designated as GTCC. Wastes with both short- and long-lived radionuclides use the more restrictive classification (Class A < Class B < Class C < GTCC) as determined by the two SOF. GTCC wastes require approval by the FFA managers for disposal in the EMWMF. If radioactive waste does not contain any nuclides in either table, it is Class A.

ARAR = applicable or relevant and appropriate requirement
CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act of 1980
DOE = U.S. Department of Energy
EMWMF = Environmental Management Waste Management Facility
FFA = Federal Facility Agreement
GTCC = greater-than-class-C
LLW = low-level (radioactive) waste
ORR = Oak Ridge Reservation
RA = response action
RCRA = Resource Conservation and Recovery Act of 1976
ROD = record of decision
SOF = sum of fractions
TDEC = Tennessee Department of Environment and Conservation
TSCA = Toxic Substances Control Act of 1976
WAC = waste acceptance criteria

Table A.4. Physical WAC[a]

55-gal-to-85-gal drums must be ≤ 1000 lb.
Boxes up to 96 ft^3 must be ≤ 10,000 lb.
Soft-sided waste containers up to 10 yd^3 must be ≤ 24,000 lb.
Single debris items must have dimensions ≤ 4 ft × 4 ft × 6 ft, and weights ≤ 24,000 lb.
Concrete debris can either be reduced to rubble to a maximum dimension of approximately 1 ft (and preferably mixed with soils), or shipped in large blocks (with rebar cut as flush as practical) capable of direct placement in the cell.
Steel plate dimensions should have a maximum dimension less than the inside dimension of the haulage container to aid direct dumping in the cell. It shall not be bent or forced into the container, shall be shipped separately from soils, and shall not extend above the top of the container. Cribbing may be necessary to avoid binding of the material during unloading.
Pipes shall be segregated from other wastes and shall be placed in haulage containers to avoid bridging or otherwise wedging during unloading. Pipe and tubing less than 6-in. diameter is accepted without further restrictions. Pipes between 6-in. and 12-in. diameter shall be crushed, shredded, or filled to minimize void spaces. Pipes 12-in. diameter and greater shall be split longitudinally.
Asbestos-containing materials and beryllium dust-containing wastes shall be wetted, double-bagged, and be shipped separately or with adequate volumes of soil to facilitate safe transportation and burial. Bags shall be limited to a maximum weight of 40 lbs.
Miscellaneous metals, building debris, structural steel, or conduit shall not be bent over or folded in the container and shall be easily dumped and segregated from soils. General building rubble shall be sufficiently sized or compacted to be gradable into an 18-in. layer by a D-7 Caterpillar dozer or a CAT 825 compactor, or be able to be buried in the working face if it meets the dimension criteria above.
Containerized compactible waste shall either have all voids filled with noncompressible material such as soil or grout, or be capable of being crushed by a D-7 dozer. Soft waste shall be containerized so that it can be crushed and spread.
Rebar shall be cut to a maximum 4-ft length and shall be in rolls or bundles that can be placed and graded in an 18-in. lift.
Noncrushable containers (B-25 boxes, etc.) shall be evenly loaded, and any remaining voids should be filled with noncompressible materials or grout.
Container liners shall be installed in the container prior to waste loading and shall be folded and secured over the waste after loading.
Wastes shall have dose rates no greater than 200 mrem/hr on contact, and no greater than 10 mrem/hr at 2 m from any surface of the wastes.

[a] Physical WAC are set by the EMWMF subcontractor based on routine operational condition expectations. Waivers of such WAC must be negotiated with the operational subcontractor and would likely entail a Change Notice or Request for Equitable Adjustment.

EMWMF = Environmental Management Waste Management Facility

WAC = waste acceptance criteria

APPENDIX B

PROCESS FOR DEVELOPING ANALYTIC WAC FOR NEW SITE-RELATED CONTAMINANTS

B.1 PROCESS FOR DEVELOPING ANALYTIC WAC FOR NEW SITE-RELATED CONTAMINANTS

Occasionally, contaminants may be identified in Comprehensive Environmental Response, Compensation, and Liability Act of 1980 waste that are not on the list of contaminants for which analytic waste acceptance criteria (WAC) have been calculated. Also, projects may, from time to time, desire to take waste lot-specific measurements of soil-to-liquid partition factors (K_d) to assess the waste's actual leaching potential relative to the assumed, conservative K_d values used to develop the final analytic WAC. In such cases, new analytic WAC must be developed to ensure that the waste being placed at the Environmental Management Waste Management Facility (EMWMF) will not pose a significant risk to the public.

This appendix describes how WAC will be calculated by the WAC Attainment Team using the same codes and procedures that were used to develop the WAC given in the record of decision (DOE 1999), as detailed in Appendix E of the Remedial Investigation (RI)/Feasibility Study [(FS) DOE 1998a] and in Chap. 2 of the FS Addendum (DOE 1998b). Following the process described here will assure that any WAC developed for new contaminants and waste-lot-specific WAC will have the same basis as the WAC given in Appendix A. However, other codes and procedures could be used if they are equivalent and are approved by the Federal Facility Agreement parties.

The steps described here are illustrated in Fig. B.1.

Step 1:

Assemble necessary contaminant-specific information to run the PATHRAE code (Merrell et al. 1995). This information includes the following:

- Sorption coefficients in the liner media beneath the waste, in the natural formations below the waste cell, and in various materials through which the leachate may travel on its way to the hypothetical future receptor.

- Plant and animal uptake transfer functions for use in calculating human uptakes from the food pathway.

- Risk factors relating human uptakes to incremental cancer risk.

- Reference doses.

If not all necessary contaminant-specific information is available, consideration will be given to using information from another contaminant that can be a suitable surrogate for the new contaminant.

Step 2:

When information for the new contaminant has been assembled, the PATHRAE computer code will be run. Inputs to PATHRAE from other codes used in developing the WAC [e.g., from HELP (Schroeder et al. 1994) and MODFLOW (McDonald and Harbaugh 1988)/MODPATH (Pollock 1989) outputs] should be identical to those used in prior WAC development.

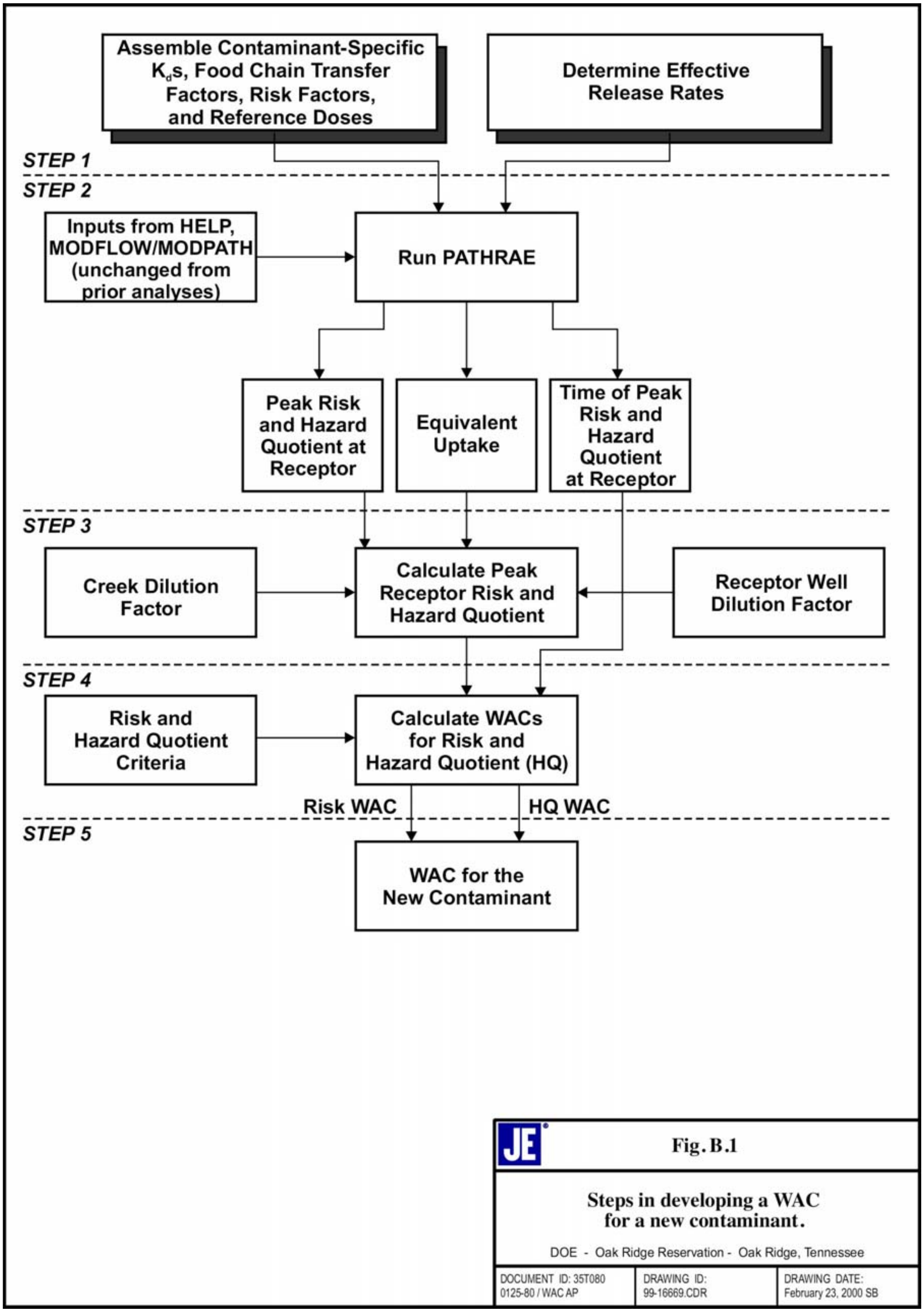

Fig. B.1. Steps in developing a WAC for a new contaminant.

PATHRAE will be used to calculate peak values of incremental lifetime cancer risk and a hazard quotient from the new contaminant, the times of occurrence of those peaks, and the equivalent uptake for the new contaminant.

The equivalent uptake calculated by the PATHRAE code is the equivalent amount of contaminated water that would have to be consumed in order to give the same contaminant uptake as would occur from both drinking contaminated water and eating contaminated food. It depends on the contaminant-specific transfer factors for the food chain and assumptions about irrigation, watering of cattle, and the diet of the receptor. For example, for the food chain used in development of the WAC in the RI/FS, the equivalent uptake for uranium is 738 L/year, where 730 L/year is the assumed uptake of contaminated water due to drinking the water. On the other hand, 956 L/year is the equivalent uptake for carbon under the same circumstances. Comparing these two equivalent uptakes shows that 8 L/year and 226 L/year equivalent of additional water ingestion are due to uranium and carbon, respectively, that enter the food chain, reflecting the relatively higher bioconcentration of carbon in the food chain.

The equivalent uptake is needed to calculate the risk and uptake at the receptor location because the receptor drinks water from one place (a well) and eats food that uses water from another place (Bear Creek).

Step 3:

Calculate the peak risk and hazard quotient experienced by the receptor. The effective dilution factors at Bear Creek and at the receptor well are used for this calculation. Since PATHRAE calculates the ingestion risk and hazard quotient for both direct consumption of 730 L of water per year from Bear Creek and consumption of food from crops and animals irrigated and watered from Bear Creek, the PATHRAE-calculated risk and hazard quotient must be altered to explain the different dilution factor attributed to the water drawn from the receptor well. This adjustment is made by removing from the PATHRAE-calculated risk the portion of that risk due to direct consumption of water, multiplying it by the ratio of the dilution factor at the well to the dilution factor at the creek, and adding it back in to the risk. For uranium isotopes, this means that 730/738 of the PATHRAE-calculated risk would be removed, multiplied by the ratio of the dilution factors, and added back in.

Step 4:

Calculate waste acceptance criteria for the new contaminant, based on the risk and hazard quotient criteria defined for the EMWMF. Since the numerical criteria being applied to the EMWMF depend on the time of receptor uptake (before or after 1000 years following closure of the facility), the peak time information from PATHRAE is used in this step. Peak times given by PATHRAE are for contaminants reaching Bear Creek or reaching a well through movement in the upper (unconfined) aquifer. Peak projected risks and doses to the receptors from drinking water from the well and from eating food watered and irrigated from Bear Creek could occur at different times, depending on the speed with which the contaminant moves through the groundwater system between the well and the creek. Consequently, care must be taken in choosing which criteria (those for before 1000 years or those for after 1000 years) are applied in calculating the WAC. Also, any significant decay (for radioactive contaminants) or degradation (for hazardous chemical contaminants) that could occur between the well and the creek must be explained.

B.2 REFERENCES

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APPENDIX C

GENERIC GUIDANCE FOR DATA COLLECTION, DATA ANALYSIS, AND FORMULATION OF SAMPLING PLANS

C.1 INTRODUCTION

One of the more fundamental aspects of waste acceptance criteria (WAC) attainment is the ability to collect appropriate data, analyze it in a consistent and rigorous manner, and formulate plans to mitigate any data insufficiencies. This appendix outlines this process and refers to appropriate regulatory guidance for more specific details when needed.

A flow diagram of the overall data evaluation process is present in Fig. C.1. The first four steps relate to the collection of data and evaluation of the data to determine which WAC constituents are site-related contaminants (SRCs). The next two steps relate to analysis of the data to produce the inputs required by the Waste Acceptance Criteria Forecasting Analysis Capability System (WACFACS), which is the principal analytical tool that will be used to calculate the sums-of-fractions (SOFs) for waste lots and the volume-weighted sums of fractions (VWSFs) for the Environmental Management Waste Management Facility (EMWMF). The final two steps relate to the identification of data gaps and their mitigation, either prior to response actions (RAs), during RAs, or both.

C.2 DETERMINATION OF SITE-RELATED CONTAMINANTS

An SRC is a chemical or radionuclide that has a WAC limit and is present in a waste lot in concentrations that are above background. SOFs are calculated for all SRCs with analytic WAC limits and, conversely, constituents that are not SRCs are excluded from SOF calculations. Other SRCs are those associated with Resource Conservation and Recovery Act of 1976 (RCRA) and Toxic Substance Control Act of 1976 (TSCA) land disposal restriction (LDR) compliance requirements. Still others are used to assess whether ASA-derived WAC limits are being exceeded such that special waste handling provisions are warranted.

This appendix focuses mainly upon the data requirements necessary to meet analytic and ASA-derived WAC needs. Specific data quality objectives (DQOs) have been set for analytic WAC compliance and are presented in Appendix E. Though specific DQOs have not been set for ASA-derived WAC compliance, it is generally acceptable to have large uncertainties in reported concentrations for these purposes (e.g., purely high-biased data are often acceptable for ASA-derived WAC compliance, but they are often not acceptable for analytic WAC compliance). Sampling goals for ASA-derived WAC compliance for constituents that do not have analytic WAC limits often focus on upper confidence limits without consideration of expected concentrations. This focus often leads to biased sampling approaches to maximize the efficiency of any further sample data collected, if the data developed for analytic WAC compliance is not sufficient for this purpose. Data requirements for LDR compliance can be found in RCRA and TSCA regulations and supporting guidance and may result in additional sampling beyond that needed for analytic and ASA-derived WAC compliance.

In order to determine whether a waste constituent is an SRC, data for the constituent must be available and representative of the wastes to be disposed. The sources of these data can be analytical data from past CERCLA investigations, which are typically found in the Oak Ridge Environmental Information System (OREIS), or from other investigations such as sampling done to support early removal actions or remedial designs. Data also can been anecdotal, such as from process knowledge associated with a facility or site, or from established relationships of contaminants (e.g., the absence of ^{137}Cs and ^{90}Sr being used as an indication of the absence of all fission products).

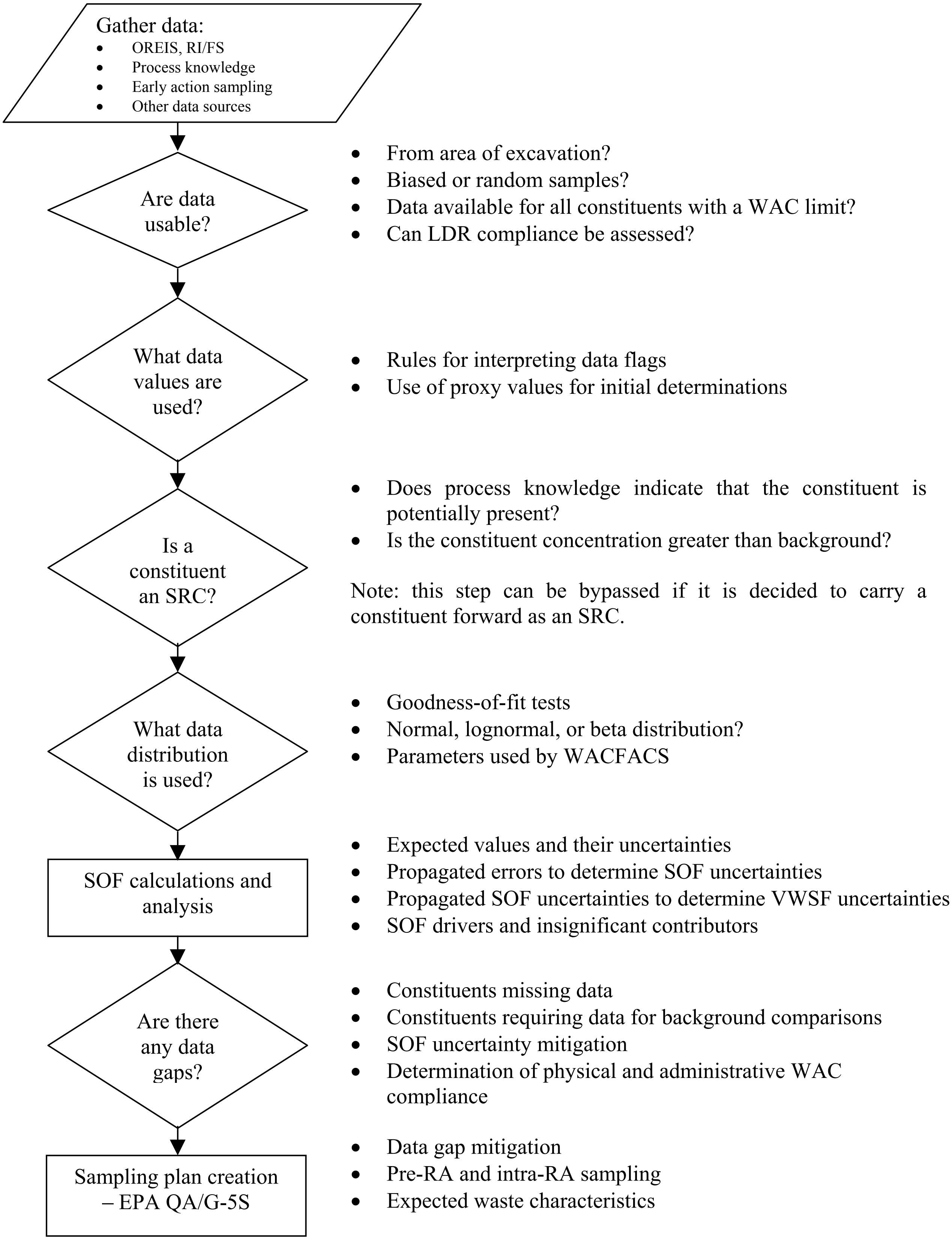


Fig. C.1. Overall data evaluation flowchart.

Once data are gathered, there are often factors that complicate the evaluation of this existing information relevant to determining WAC compliance. For instance, analytical data may exist, but they may have been derived from samples outside of the planned area of excavation or they may not exist for all areas of planned excavation. Also, sampling efforts to support CERCLA site investigations often involve the collection of biased samples to identify and bound site conditions instead of being aimed at determining site average concentrations of a waste lot. Finally, data may not be available for all WAC constituents, which would indicate a data gap that must be filled prior to waste acceptance for disposal.

C.2.1 IDENTIFICATION OF EXISTING WASTE DATA

Data for projects exist in many forms and from many sources. One goal of data analysis associated with WAC compliance is to assess compliance with RCRA and TSCA LDRs and to determine whether waste treatment is required. Another goal is to derive the representative average concentrations of the wastes disposed in the EMWMF and the uncertainty of those average concentrations. These average concentrations and their uncertainties will be used to make determination of whether wastes are acceptable for disposal in the EMWMF and whether additional analytical data are needed to confirm this initial assessment, better estimate the average concentrations in the wastes, or both.

Analytical data collected for most CERCLA projects are typically found in OREIS and/or project files. However, care must be taken to ensure that data are selected from sampling locations within the area from which wastes are planned to be generated and that the data are representative of the wastes expected to be generated. In order to accomplish this, it may be necessary to review field data, sampling plans, and data reports to ascertain how samples were chosen and collected.

Process knowledge or anecdotal evidence can be used to supplement analytical data. Knowledge of building operations, inventories, site deposition patterns, etc., can be used to indicate the potential presence or absence of a constituent. Also, analytical data from similar sites or processes may be used as anecdotal evidence to gauge the potential presence and concentration for waste constituents that do not have site analytical data, and to determine whether wastes are potentially acceptable for disposal at the EMWMF. If such analytical data are used in initial WAC compliance determinations, the source of the anecdotal data should be recorded and the waste constituent should be noted as a potential data gap.

C.2.2 DATA USABILITY

Ideally, purely unbiased analytical data within the actual area of excavation will be used to determine expected average concentrations of waste to be placed in the EMWMF. However, given the varied sources of data and the need to strike a balance between data collection and analytical costs, other considerations may apply.

Definitive process knowledge may be sufficient to justify the elimination of a waste constituent as an SRC without the need for analytical data. In cases where process knowledge is less certain, a combination of process knowledge and limited analytical data may be sufficient. In either case, the justification for such determinations should be stated explicitly in a sampling and analysis plan, a waste management plan, or another RA project CERCLA document.

In other cases, biased data may exist that skew the statistical parameters in an overly conservative manner. When this occurs, the effects of the biased data must be evaluated. If the incorporation of biased data does not materially affect the calculations of SOF (i.e., the contaminant represents a small fraction of the analytic WAC even using the biased data), then the biased data can be accepted as representative of the wastes. However, if the incorporation of biased data significantly impacts the SOF calculations, additional data that is representative of the expected wastes to be generated may be required to address these potential data gaps. If possible, the degree of bias should be estimated to predict the actual average concentration for unbiased samples in order to determine whether the wastes are potentially acceptable for disposal in the EMWMF. If the wastes appear to be likely candidates for disposal, then sampling plans for these wastes should include the collection of unbiased samples for the contaminants of interest. The goal for collecting these additional samples is the determination of representative average concentrations of waste contaminants contributing significantly to the SOFs.

C.2.3 INTERPRETATION OF DATA FLAGS

Contract laboratory data are often accompanied by laboratory data qualifiers and, if validated, validation qualifiers. Rules for interpreting data qualifiers are found in EPA's Risk Assessment Guidance for Superfund [(RAGS) EPA 1989] Part A. Because RAGS was used in developing analytic WAC concentrations for the EMWMF, it is appropriate to use this guidance for the evaluation of data used to demonstrate analytic WAC attainment. These same rules are also appropriate for evaluating data for administrative and ASA-derived WAC compliance purposes.

For cases in which data have undergone validation, validation qualifiers will always take precedence over laboratory qualifiers. For unvalidated data, laboratory data qualifiers will be used to assign equivalent validation codes. In general, uncertain data are replaced with proxy values, which are then used in subsequent statistical analyses.

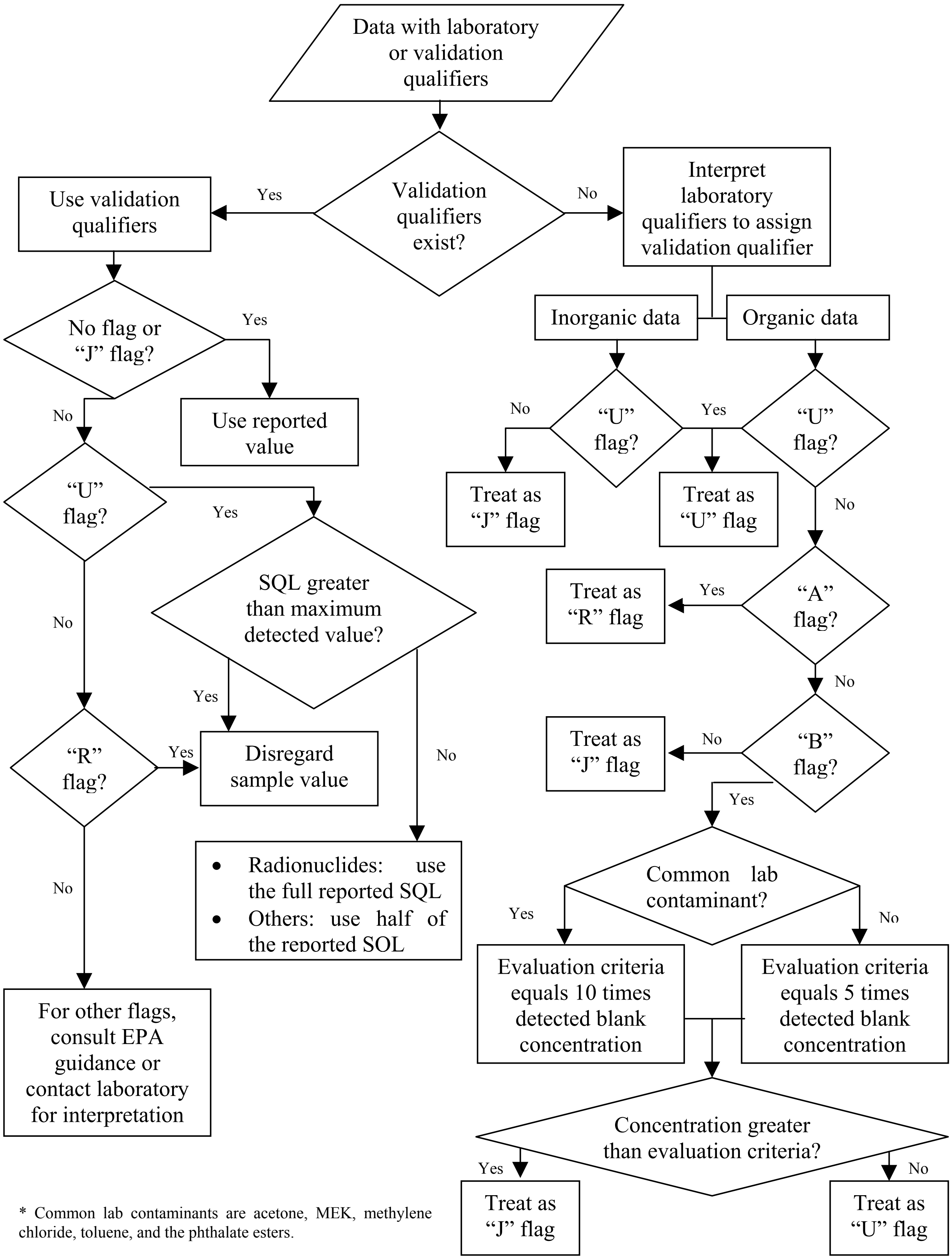
Figure C.2 outlines the logic for interpretation of data qualifiers. If more specific guidance is needed beyond that presented in Fig. C.2, RAGS and other EPA guidance for data interpretation [e.g., regional bulletins and EPA's *Guidance for Data Useability in Risk Assessments* (EPA 1992)] should be consulted.

C.2.4 DECISION RULES TO DETERMINE SRCs

The overall logic for screening constituents to determine whether they are SRCs is presented in Fig. C.3. The decision of whether a waste constituent is an SRC will depend largely on process knowledge and comparisons to background concentrations or detection rates. In general, any constituent with a significant detection is to be considered an SRC. Otherwise, the following guidelines can be used to determine whether a constituent can be screened out of SOF calculations.

The first step is to determine whether process knowledge indicates the potential presence of a WAC constituent for the waste lot under consideration. If definitive process knowledge exists that a constituent should not be present, then it may be screened out of the assessment on this basis alone; the CERCLA documentation for the project should identify these determinations. Any anecdotal evidence supporting this assertion should also be reported.

If definitive process knowledge does not exist supporting the elimination of a constituent, but also does not exist indicating a constituent should be present, then the constituent can still be screened out based upon its detection rate. If all "detected" concentrations are "J" flagged data or equivalent, then a detection rate of less than 20% of the samples present can be used as sufficient evidence of the absence of the constituent. If some values are not flagged but are only nominally above their SQLs (e.g., a reported concentration less than approximately two times the reported SQL), then a detection rate of less than 5% of the samples can be used as a decision rule.



* Common lab contaminants are acetone, MEK, methylene chloride, toluene, and the phthalate esters.

Fig. C.2. Interpretation of data qualifiers.

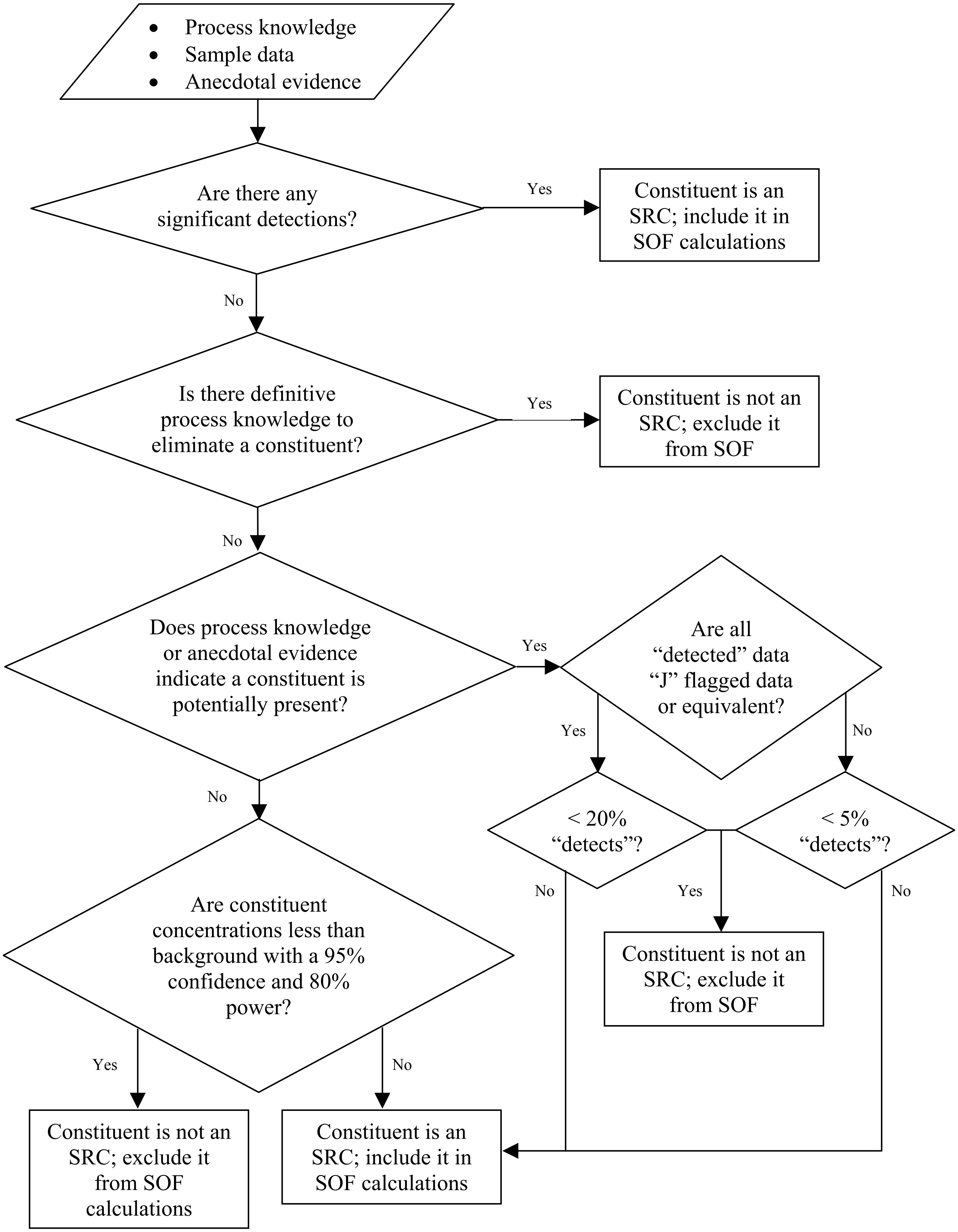


Fig. C.3. Determination of site-related contaminants.

Determinations of the absence of a constituent using detection rates must also consider whether a representative number of samples has been collected. For relatively homogenous wastes, representativeness is assumed when at least 5 samples are available to ascertain that a detection rate is less than 20%, or when 20 samples are available to ascertain that a detection rate is less than 5%. For relatively heterogeneous wastes, larger sample populations may be required. If biased samples representing expected maximum concentrations for a waste lot are available for these comparisons, or when sufficient process knowledge exists to support the elimination of a constituent as an SRC, smaller sample populations can be used.

For constituents with background concentrations and one or more significantly detected concentrations (i.e., a sample result that is significantly greater than its SQL), sample concentrations can be compared with the expected range of background levels. If the concentrations fall within this range, it can be excluded from the list of SRCs. The specific comparison criteria to use for these comparisons is expressed in DQO Decision 2, found in Appendix E, which specifies a 5% false negative rate and a 20% false positive allowance (95% confidence and 80% power). The data used for this screening must be of sufficient quality to perform the analysis, i.e., the SQLs must be less than the background concentrations. As with other such determinations, the basis for this elimination must be included in the CERCLA documentation for the project.

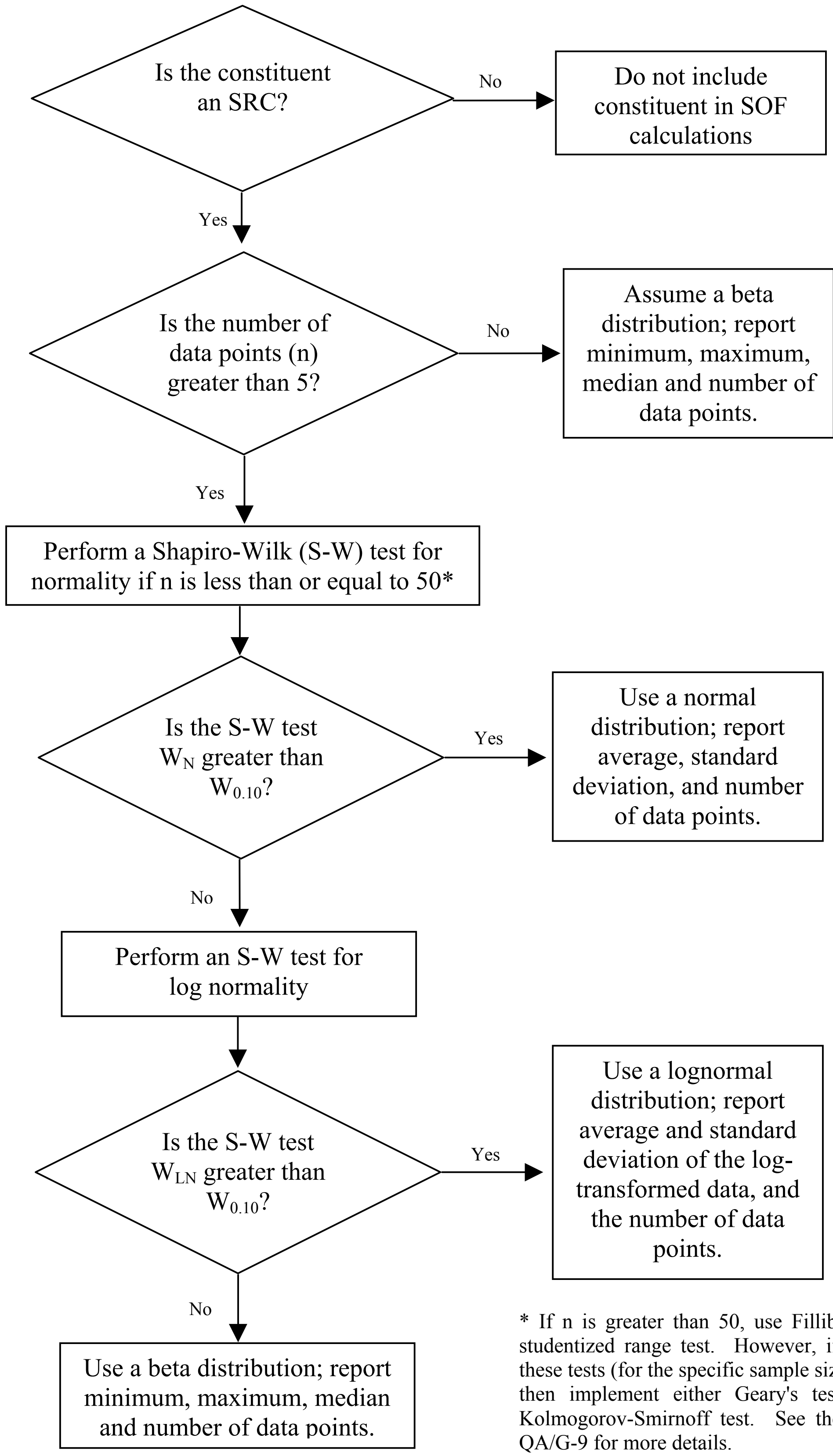
If a constituent is not screened out as an SRC, it must be carried forward in the subsequent calculations of analytic WAC SOFs and ASA-derived WAC compliance. A project may elect to carry a constituent forward as an SRC without explicitly screening it against detection rates or background concentrations, even if it is suspected that such efforts may result in its elimination as an SRC. This may be desirable for certain constituents with large WAC concentration limits such that, at background levels, they represent an SOF less than 0.01. In such cases, the effort to eliminate the constituent as an SRC may not be warranted against the minimal effect it would have on SOF calculations. This is consistent with the logic behind the statistical goals for DQO Decision 2, which were set with a desire to ensure waste contaminants were not inappropriately screened out, but with a much larger tolerance being given to inappropriately saying a constituent was present when in fact it was not.

C.3 DATA ANALYSES TO DERIVE WASTE LOT SOFs

Figure C.4 diagrams the overall data distribution analysis process. Once the list of SRCs has been determined, the next step is to analyze the data to determine the representative average concentrations and their uncertainties. The distributions of the data populations must be determined and descriptive statistical parameters calculated for use in WACFACS. Once these parameters are known, WACFACS will be used to calculate the expected value and its uncertainty of the waste lot SOFs.

The determination of data distributions is accomplished by following EPA's guidance for data quality assessment, *Practical Methods for Data Analysis* [(EPA QA/G-9) EPA 2000a]. In general, three distributions have been chosen for use by WACFACS: normal, lognormal, and a three-point PERT beta distribution (hereafter referred to as a beta distribution). These distributions were chosen based upon EPA CERCLA risk assessment guidance, which prescribes the use of normal or lognormal distributions. The beta distribution was added as a third choice based upon its ability to mimic either a normal or lognormal distribution.

When five or fewer data points are available, the beta distribution is to be assumed, and the minimum, median (i.e., the 50th percentile), and maximum values are to be reported along with the



* If n is greater than 50, use Filliben's statistic or the studentized range test. However, if critical values for these tests (for the specific sample size) are not available, then implement either Geary's test or the Lilliefors Kolmogorov-Smirnoff test. See the guidance in EPA QA/G-9 for more details.

Fig. C.4. Data distribution analysis.

number of data points. The use of these descriptive statistics will provide a beta distribution that is shaped roughly like either a normal or lognormal distribution.

When more than five data points exist, goodness-of-fit tests are to be performed to determine the best distribution to use. Specifically, the Shapiro-Wilk (S-W) Test is to be used to determine whether a normal distribution provides a sufficient fit, with the computed W values compared to $W_{0.10}$ evaluation criteria. If the W value exceeds its associated $W_{0.10}$ evaluation criterion, a normal distribution is to be used and the average, standard deviation, and number of data points for the data set are to be reported.

Since the S-W Test is applicable for only up to 50 data points, other tests are required for larger data sets. If more than 50 data points are available, EPA QA/G-9 (EPA 2000a) specifies the use of Filliben's statistic or the studentized range test. However, if critical values for these tests (for the specific sample size) are not available, then EPA QA/G-9 specifies either Geary's test or the Lilliefors Kolmogorov-Smirnoff test. Consult the guidance in EPA QA/G-9 for more details in these cases.

If a normal distribution is found to be inadequate, the data are then tested to determine if a lognormal distribution provides a sufficient fit. The S-W Test is to be used on the log-transformed data, with the new W values again compared to the $W_{0.10}$ evaluation criterion. If the S-W Test indicates a lognormal distribution is adequate, then the average and standard deviation of the log-transformed data are to be reported, as well as the number of data points.

If the goodness-of-fit tests indicate that neither a normal nor a lognormal distribution is adequate, a beta distribution is to be assumed. The values to be reported are the minimum, median, and maximum values and the number of data points.

Once the data distribution is known and the relevant descriptive statistics are reported, WACFACS will be used to calculate the expected SOF and its uncertainty. Though an expected average SOF value can be calculated using the predicted mean values of each contaminant, the process of correctly propagating each contaminant's uncertainty is a nontrivial exercise requiring the use of Monte Carlo simulations. Using the expected values and uncertainties of the SOFs, WACFACS can also determine the expected value and uncertainty in the VWSF calculations. See Appendix D for more details on the calculations that WACFACS performs.

Once the SOFs and their uncertainties are calculated, it is possible to determine which contaminants are significantly affecting the waste lot's SOFs and their uncertainties. In general, any contaminant with a concentration greater than 1% of an analytic WAC limit and which contributes greater than 1% of the final expected or upper confidence limit (UCL) SOF can be considered a significant contributor to the SOF calculations. If an analysis of the output of the VWSF calculations from WACFACS indicates the uncertainty of a waste lot's SOF significantly contributes to the 90% upper confidence limit (UCL_{90}) VWSF, the significant SOF contributors will be examined to determine whether additional samples are needed to mitigate the uncertainty in their average concentrations. The decision to obtain additional samples for this purpose will utilize a graded approach, under which the cost of obtaining the data are balanced against the desire to minimize the difference between the expected mean VWSF and its UCL_{90}.

For ASA-derived WAC compliance, the UCL_{95} concentrations will be used to calculate the associated SOF. This will allow a very conservative assessment of compliance with the auditable safety analysis that forms the basis of this WAC limit. Because the only implication of exceeding this WAC is an indication that the open operating face will need to be restricted for that waste lot, there are no data gaps anticipated with mitigating the conservativeness of these calculations.

C.4 DETERMINATION AND MITIGATION OF DATA GAPS

In order to declare analytic WAC SOF calculations complete, the underlying data upon which it depends must be complete and sufficiently confident in its determinations of waste lot average concentrations to make accurate predictions of the VWSFs. Any additional data required to meet these goals is considered a data gap. Other data gaps may exist when there are insufficient data to assess administrative WAC compliance (e.g., LDR determinations) or ASA-derived WAC compliance.

Confirmation of most administrative WAC is essentially as simple as confirming that wastes are from CERCLA actions and are not transuranic or high-level wastes by definition. Assurance that these criteria are met essentially takes the form of answering yes/no questions for a checklist of requirements. However, when determining RCRA and TSCA LDR compliance, relevant EPA sampling guidance should be consulted to determine any additional data needs.

Confirmation of ASA-derived WAC compliance will be assured when representative concentrations are available for all listed radionuclides, or definitive process knowledge or anecdotal evidence indicates an expectation that their concentrations are less than 1% of the listed limits. One example of acceptable anecdotal evidence is involves the use of gross alpha and gross beta measurements. When the total unaccounted activity of either gross alpha or gross beta concentrations (i.e., the gross measurement minus the sum of all radionuclide-specific alpha or beta concentrations including any daughter products expected to be in secular equilibrium) is less than 1% of the most restrictive ASA-derived WAC, no additional radionuclide-specific measurements are required to meet this WAC.

Due to their relative simplicity, the identification of data gaps for administrative WAC compliance and ASA-derived WAC compliance will not be discussed further. The following text discusses the identification of data gaps for analytic WAC compliance. The processes used for these determinations are somewhat more complex. Generally, EPA's *Guidance for Choosing a Sampling Design for Environmental Data Collection* [(EPA QA/G-5S) EPA 2000b] will be used for developing sampling plans to address analytic WAC data gaps.

C.4.1 IDENTIFICATION OF ANALYTIC WAC DATA GAPS

Many of the previous data analysis steps already have obvious cases where data gaps exist, such as when there are no data available for an analytic WAC constituent with a concentration limit (i.e., there are no sample data, process knowledge, or even anecdotal evidence to estimate concentrations or determine whether a WAC constituent is present or absent in a proposed waste lot).

However, even in cases where representative data of good quality exist, it is still possible to have situations in which additional data are needed. Figure C.5 provides a logic flow diagram for the decision process used to make these determinations.

One such case would be a waste constituent that is expected to be at or below background concentrations and that represents a meaningful percentage of a WAC at those concentrations. In such cases, additional data to ensure that a constituent is at or below background with the prescribed 90% confidence and 80% power will be needed.

Other cases can arise for waste contaminants that contribute significantly to SOF calculations or their uncertainties. One possibility frequently arises when SOFs are calculated using a significant number of biased data. In such cases, the collection of additional, unbiased data may reduce both the overall SOF

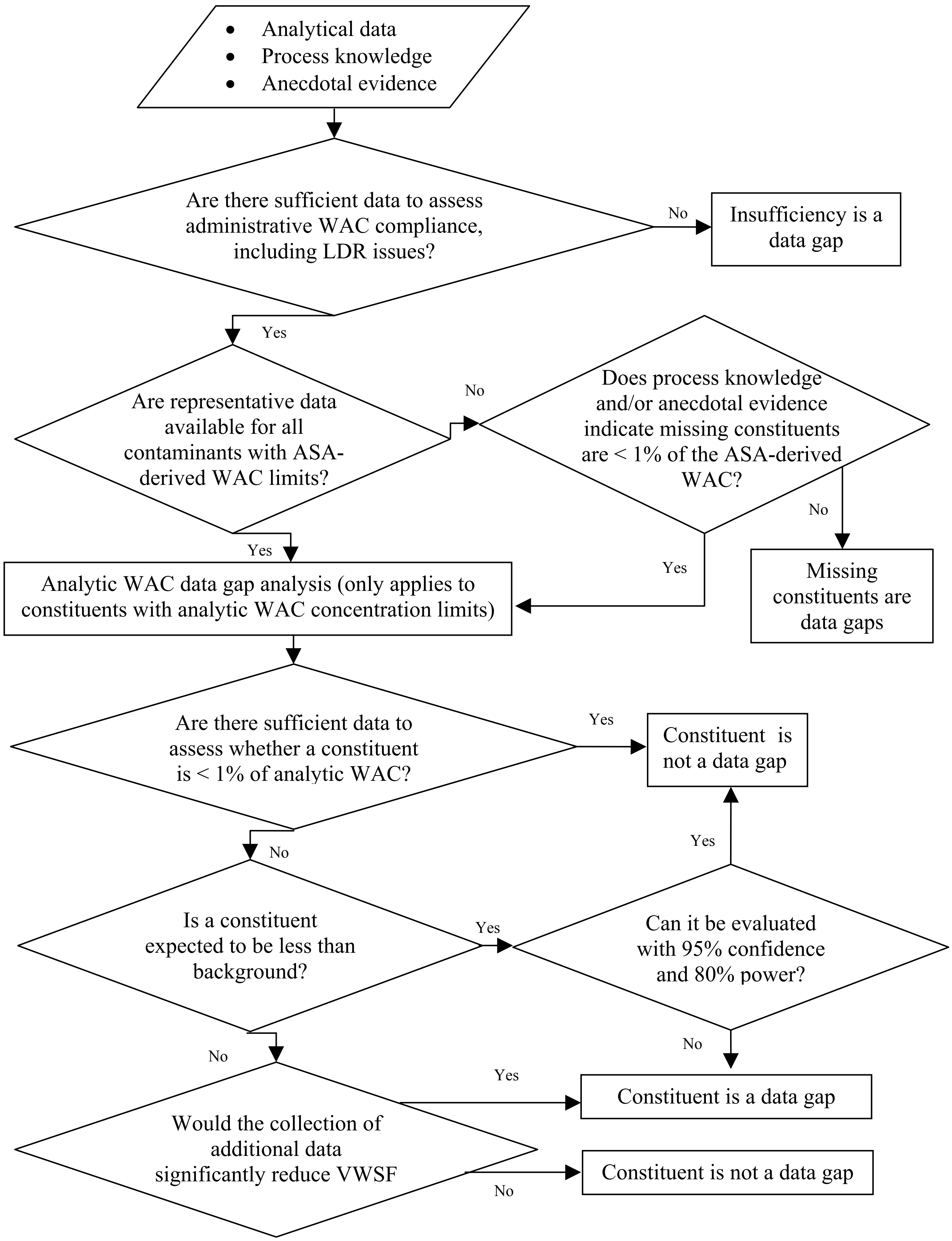


Fig. C.5. Data gap analysis.

and its uncertainty in a meaningful way. Also possible are cases in which the uncertainty of the average concentration for a waste contaminant is a driver for the overall SOF uncertainty. When the SOF uncertainty yields unacceptable effects on the VWSF uncertainty, additional samples for the waste contaminant may be warranted. The goal of these additional samples would be to refine the estimate of its average concentration in order to yield reductions in the overall SOF uncertainty and, thus, the VWSF uncertainties.

C.4.2 DEVELOPMENT OF SAMPLING AND ANALYSIS PLANS

The exact structure and timing for collecting additional samples is by necessity a project-specific determination. Also, different data collection goals often indicate a need for specific sampling strategies. Generic guidance for designing sampling plans to meet these various goals can be found in EPA QA/G-5S (EPA 2000b).

The ultimate use of any additional data being collected must be considered in the creation of sample designs. For instance, when sampling for analytic WAC compliance, it is important to remember that average concentrations will be used to calculate SOFs. As such, methods geared toward the determination of average concentrations and their uncertainties are appropriate. Therefore, composite sampling, while less desirable for many applications, may offer significant advantages towards meeting these goals. However, LDR compliance comparisons generally use comparisons of maximum concentrations to prescriptive regulatory limits, and limited numbers of biased samples often is an efficient way to fulfill these data needs. Biased samples may also be useful if the maximum concentration at a site is expected to be less than 1% of an analytic or ASA-derived WAC, as the cost to refine estimates of averages in these cases is often disproportionate to the benefits gained in refining SOF estimates.

Sampling and analysis plans designed to mitigate all identified data gaps may be incorporated into the project's Waste Management Plan or can be a stand-alone document. Example outlines for these plans are given in Figs. C.6 and C.7, respectively.

The implementation of sampling plans can occur prior to the RA, during the RA, or both, depending upon the specific needs of the project. Generally, if a project has sufficient evidence supporting waste characterization but desires to obtain additional samples to mitigate concentration uncertainties, intra-RA sampling (i.e., sampling performed during the generation and disposal of wastes) may be desirable. In cases where insufficient characterization exists prior to waste generation to support a determination that wastes can be disposed in the EMWMF, some or all of the planned samples must be obtained prior to the RA. If the wastes in a particular waste lot can be adequately characterized prior to their generation, then all of the planned samples may be obtained prior to the RA if desired (e.g., to maximize the efficiency of waste generation schedules).

In all cases, however, a waste management plan must specify how waste anomalies will be identified and characterized for separate determination of acceptability for disposal in the EMWMF. Identification methods should maximize those already available in the field for all RA activities. These include visual determinations and environment, safety, and health screening instruments, and often include methods being used for U.S. Department of Transportation compliance requirements.

- PROJECT DESCRIPTION

- PROJECT PARTICIPANTS AND RESPONSIBILITIES
  - U.S. Department of Energy
  - Bechtel Jacobs Company LLC
  - Remedial action subcontractor
  - EMWMF subcontractor

- WASTE CHARACTERIZATION
  - Waste characterization for disposal
    - Summary of existing data
    - Evaluation of data gaps for WAC attainment
    - Waste characterization plan
      - Sample locations
      - Sampling method to obtain representative samples
      - Analytical requirements (analytes and CAS numbers, analytical methods, reporting levels)
      - QA/QC sample requirements
      - Data verification and validation
      - Data management
    - Waste profile for acceptance of waste for disposal
  - Verification of remedial action objectives

- WASTE GENERATION
  - Types of wastes generated
    - Remedial action wastes
    - Soil dewatering fluids
    - Personal protective equipment (PPE)
    - Equipment decontamination waste
    - Sanitary wastes
  - Waste quantities
- WASTE ACCEPTABLE FOR DISPOSAL AT EMWMF
- WASTE ANOMALIES IDENTIFIED DURING EXCAVATION
  - Identification of waste anomalies
  - Characterization of anomalies
  - Comparisons to existing waste lot characterization results and waste acceptance determination (either in the existing lot or as a separate waste lot)

- WASTE HANDLING AND STAGING
  - Wastes for disposal at EMWMF
  - Waste anomalies not suitable for disposal at EMWMF
  - Dewatering fluids
  - PPE
  - Equipment decontamination wastes
  - Sanitary wastes
  - Waste containers and labeling requirements

Fig. C.6. Example generic waste management plan outline.

- WASTE TREATMENT
  - Remedial action wastes
  - Equipment decontamination fluids
- WASTE TRANSPORTATION
- WASTE DISPOSAL
- WASTE MINIMIZATION
- REFERENCES
- APPENDICES

Fig. C.6 (continued)

- INTRODUCTION

- SITE BACKGROUND AND PHYSICAL SETTING

- DATA QUALITY OBJECTIVE PROCESS FOR (PROJECT NAME HERE)
    - Summary of waste characterization sample planning meeting (see appendix for meeting minutes)
    - Previous studies and existing data
    - Areas of interest
    - Evaluation of existing data
    - Identification of data gaps for EMWMF WAC attainment

- SAMPLING PLAN
    - Number of samples
    - Sampling locations and depths
    - Sampling method
    - Analytical requirements (analytical constituents and CAS number, analytical methods, detection limits)
    - QA/QC sample requirements

- FIELD ACTIVITIES
    - Trenching, boring, etc.
    - Sample selection and preparation (e.g., grinding)
    - Sample management (e.g., staging, labeling, shipment, chain of custody, etc.)

- DATA MANAGEMENT AND VALIDATION

- WASTE MANAGEMENT DURING SAMPLING
    - Types of waste generated
        - Personal protective equipment (PPE)
        - Equipment decontamination waste
        - Sanitary wastes
    - Waste quantities
    - Waste containers and labeling requirements
    - Waste disposition

- REFERENCES

- APPENDIX –Waste characterization sample planning meeting minutes

Fig. C.7. Example generic sampling plan outline.

C.5 REFERENCES

EPA (U.S. Environmental Protection Agency) 1989. *Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (Part A)*, EPA/540/I-1989/002. Office of Emergency and Remedial Response, Washington, D.C.

EPA (U.S. Environmental Protection Agency) 1992. *Guidance for Data Useability in Risk Assessment*. Office of Emergency and Remedial Response Publication No. 9285.7-09A and B, Office of Emergency and Remedial Response, Washington, D.C.

EPA (U.S. Environmental Protection Agency) 2000a*. EPA QA/G-9, Guidance for Data Quality Assessment*, EPA/600/R-98/084 (QA00 Update).

EPA (U.S. Environmental Protection Agency) 2000b. *EPA QA/G-5S, Guidance For Choosing a Sampling Design for Environmental Data Collection*, (Peer review draft).

APPENDIX D

EMWMF WASTE ACCEPTANCE CRITERIA FORECASTING ANALYSIS CAPABILITY SYSTEM (WACFACS)

D.1 OVERVIEW

D.1.1 SUMMARY

The Waste Acceptance Criteria Forecasting Analysis Capability System (WACFACS) is a waste management decision tool that supports waste acceptance criteria (WAC) attainment data quality objective (DQO) decisions.

- WACFACS inputs are obtained from extensive historical and current databases [e.g., Oak Ridge Environmental Information System (OREIS)] and the Waste Generation Forecast (WGF) project volume database.

- WACFACS is a modern waste management tool used to address specific key issues and decisions based upon the WAC attainment DQO requirements. WACFACS follows U.S. Environmental Protection Agency (EPA) policy to use Monte Carlo Analysis (MCA) probabilistic techniques with environmental data.

- WACFACS outputs include the sum of fractions (SOF) and volume-weighted sum of fractions (VWSF) at the Environmental Management Waste Management Facility (EMWMF). In order to manage uncertainty, WACFACS combines the inputs and their uncertainties to propagate the uncertainties through the SOF and VWSF calculation.

WACFACS is used by the WAC Attainment Team and by remedial action (RA) projects or subprojects that intend on implementing waste disposition actions at the Environmental Management Waste Management Facility (EMWMF). Other users include EMWMF operational personnel and waste management and strategic planners. WACFACS outputs are generated for three time periods: (1) a project duration [for example, fiscal year (FY) 2002–2003], (2) a 3-year planning window (e.g., FY 2002–2004) for WAC attainment calculations, and (3) the EMWMF life cycle baseline (LCB) planning cycle.

WACFACS has three significant capabilities:

- Data management—WACFACS requires that all input data follow EPA DQO, usability, and data quality assessment (DQA) guidance. WACFACS identifies key drivers that influence SOF and the upper 90% confidence limit for the VWSF, denoted as UCL_{90} (VWSF).

- Uncertainty management—WACFACS capitalizes on the variability and the uncertainties present in site-related contaminant (SRC) and volume data to propagate these effects to compute the SOF and the UCL_{90} (VWSF). WACFACS quantifies the uncertainties in real time for the project SOF and UCL_{90} (VWSF) over fiscal years and quarters.

- Sensitivity management—WACFACS can identify SRC, volume, and schedule drivers of the UCL_{90} (VWSF). WACFACS SOF results may indicate additional field sampling by the project to mitigate UCL_{90} (VWSF) uncertainties. The VWSF forecasting and analysis of uncertainties supports short-term and strategic decisions and alternatives analyses.

This appendix is structured in the following manner:

- This overview provides an introduction to WACFACS. First, WACFACS is summarized. Next, EPA guidance documentation is identified to establish the regulatory basis for WACFACS. A simple graphical expression of the WACFACS architecture (the relation of the inputs, the outputs, the constraints, and the WACFACS process) is provided. The WAC attainment issues and decisions addressed by WACFACS are discussed. Finally, a summary of the WACFACS concept of operations is presented.

- Section D.2 discusses WACFACS inputs. This is a detailed discussion of input data requirements, data sources, quality assurance/data usability, and actions that must be taken to ensure credible inputs are used in the WACFACS process. Illustrative examples of input data are provided.

- Section D.3 discusses the WACFACS outputs. This section presents the form and format of the WACFACS measures used to key issues and decisions. Illustrative examples of output calculations are provided.

- Section D.4 provides supplemental details of the WACFACS process to include the MCA probabilistic technique, and the manner in which WACFACS deals with data management, uncertainty management, and sensitivity management is presented.

D.1.2 REGULATORY GUIDANCE

Three EPA documents provided regulatory guidance in developing the basis for WACFACS:

- *Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (Part A)* (EPA 1989). This document summarizes and highlights important concepts and steps of the remedial investigation/feasibility study (RI/FS) relevant to risk assessment, including data quality and usability. The term “usability” is employed to describe actions performed to determine whether data are credible and representative of actual site conditions.

- *Guidance for Data Quality Assessment* (EPA 2000c). This document provides general guidance on assessing data quality criteria and performance specifications for decision making. It is the culmination of experiences in the design and statistical analyses of environmental data in different program offices at EPA. Many elements of prior guidance, statistics (including the Bootstrap-t method), and scientific planning have been incorporated into this document. The term “DQA” is employed to describe actions performed to analyze data to determine appropriate statistical summaries. The term “DQO” references use of the data quality objectives process as a necessary condition to apply a DQA.

- *Guiding Principles for Monte Carlo Analysis* (EPA 1997a). This policy documents EPA’s position regarding the utilization of probabilistic analysis techniques, including “Monte Carlo analysis,” given adequate supporting data and credible assumptions. WACFACS is a probabilistic analysis tool that meets the requirements stated in this guidance document. MCA denotes the actions performed under this guidance.

Methods incorporating the concepts in the first two guidance documents are given in Appendix C to ensure proper input parameters for WACFACS are used. WACFACS has been developed using the MCA guidance to analyze data and ensure the EMWMF WAC DQOs in Appendix E are met.

D.1.3 WACFACS ARCHITECTURE

A convenient graphical portrayal of the relation of the inputs, the outputs, the constraints, and the WACFACS process to meet the key decisions for WAC attainment is presented in Fig. D.1. This graphical portrayal is called a "systems diagram." There are four components of the systems diagram.

- Inputs represent the data required for the WACFACS to be executed. This includes volume and SRC values and their associated uncertainties.
- Constraints include the time frames of interest, the applicable regulatory guidance needed to implement WACFACS, and the values of the analytic WAC.
- The WACFACS process represents the MCA engine used for data required for the WACFACS to be executed. Data management, uncertainty management, and sensitivity management are the primary functions of the WACFACS process. The MCA software used for WACFACS is @Risk (Palisade 2000).
- Outputs represent the calculations using the input data and the comparisons to the constraints. The outputs are the SOF, the VWSF, the UCL_{90} (VWSF), and the soil-to-debris ratio. The decision is based on whether the outputs meet, or do not meet, the constraints.

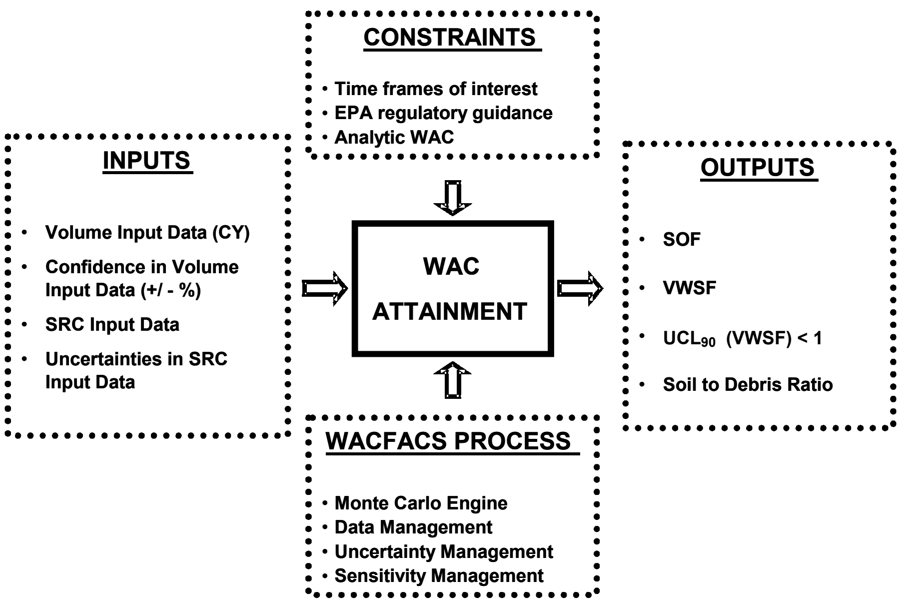


Fig. D.1 WACFACS system diagram.

D.1.4 ISSUES AND KEY DECISIONS ADDRESSED USING WACFACS

WACFACS is designed to address WAC attainment issues as discussed in the WAC attainment DQO and in conjunction with internal prime contractor organization elements. The issues addressed by these organizational elements when using WACFACS are as follows:

- Does a project or subproject meet the WAC attainment DQO?
- What planning needs to be accomplished for EMWMF utilization?
- Is the EMWMF operating efficiently?

During the WAC attainment DQO process, the stakeholders identified several key decisions. Three decisions related explicitly to the WAC attainment decisions. A fourth decision was defined as being applicable to EMWMF operations. While WACFACS may be used to address other EMWMF planning, evaluation, and control decisions, only decisions formalized through the DQO process and applicable to WAC attainment are discussed. Following are the key decisions addressed by WACFACS:

- **DQO Decision 1**: Does the waste lot data meet the form and format required by the WAC Attainment Team?

- **DQO Decision 2**: Is the existing waste lot characterization data sufficient to the waste lot SOFs?

- **DQO Decision 3**: Using a graded approach for the effects of SOF uncertainties on the VWSFs, can the waste stream be disposed at the EMWMF?

- **EMWMF Operations decision:** Is the EMWMF operating efficiently under current or projected demands?

D.1.5 CONCEPT OF OPERATIONS

The WACFACS concept of operations specifies how users examine each of the key decisions, given the constraints associated with using WACFACS. These constraints include organizational elements, time frames of interest, EPA guidance techniques, measures used to evaluate the key decisions, and thresholds associated with the measures. Figure D.2 identifies the elements of the WACFACS concept of operations.

- Two primary organizational elements utilize WACFACS. The WAC Attainment Team needs to confirm that a project or subproject meets the WAC attainment DQO. RA projects must meet the WAC attainment DQO and accommodate changes in scope or schedule that affect waste disposition. The Waste Management organization and Planning and Controls examine alternative project or subproject disposition scope, budget, or schedule. EMWMF Operations use WACFACS during operations planning and control.

- Three time frames can be examined by the organizational elements. Disposition-based time frames include the project disposition fiscal year and a specific EMWMF operational time frame of interest. The latter time frame is a “3-year window” applicable to short-term EMWMF performance planning or evaluation. At the onset of WAC attainment, this window is FY 2002–2004. Other planning time frames can be used (e.g., the EMWMF life cycle per the LCB WGF).

- SRC and volume data are obtained from the project and are subjected to one or more techniques/actions as prescribed by this WAC attainment plan in preparation for use in WACFACS. Data usability analyses are performed to ensure that credible data are used to address the key decisions. Some projects or subprojects may require sampling and analysis activities to address data gaps. DQO-like processes are employed to identify requirements for additional data collection.

- Finally, WAC attainment DQO decisions are addressed using WACFACS. The primary measure for determining whether the decision is met or not met is the “upper confidence limit” (UCL) of the VWSF. The UCL_{90} is the measure of merit selected by the Federal Facility Agreement parties for the VWSF. The UCL_{90} is the value for which 90% of the time the average VWSF is less than 1 or, equivalently, 10% of the time the average SOF is greater than 1. Using the MCA approach, WACFACS employs simulation software as described in Palisade (2000). A Bayesian updating approach is applied in estimation of the SOF and the VWSF, and the techniques identified in SAS (2000) and Redus (1994) are applicable.

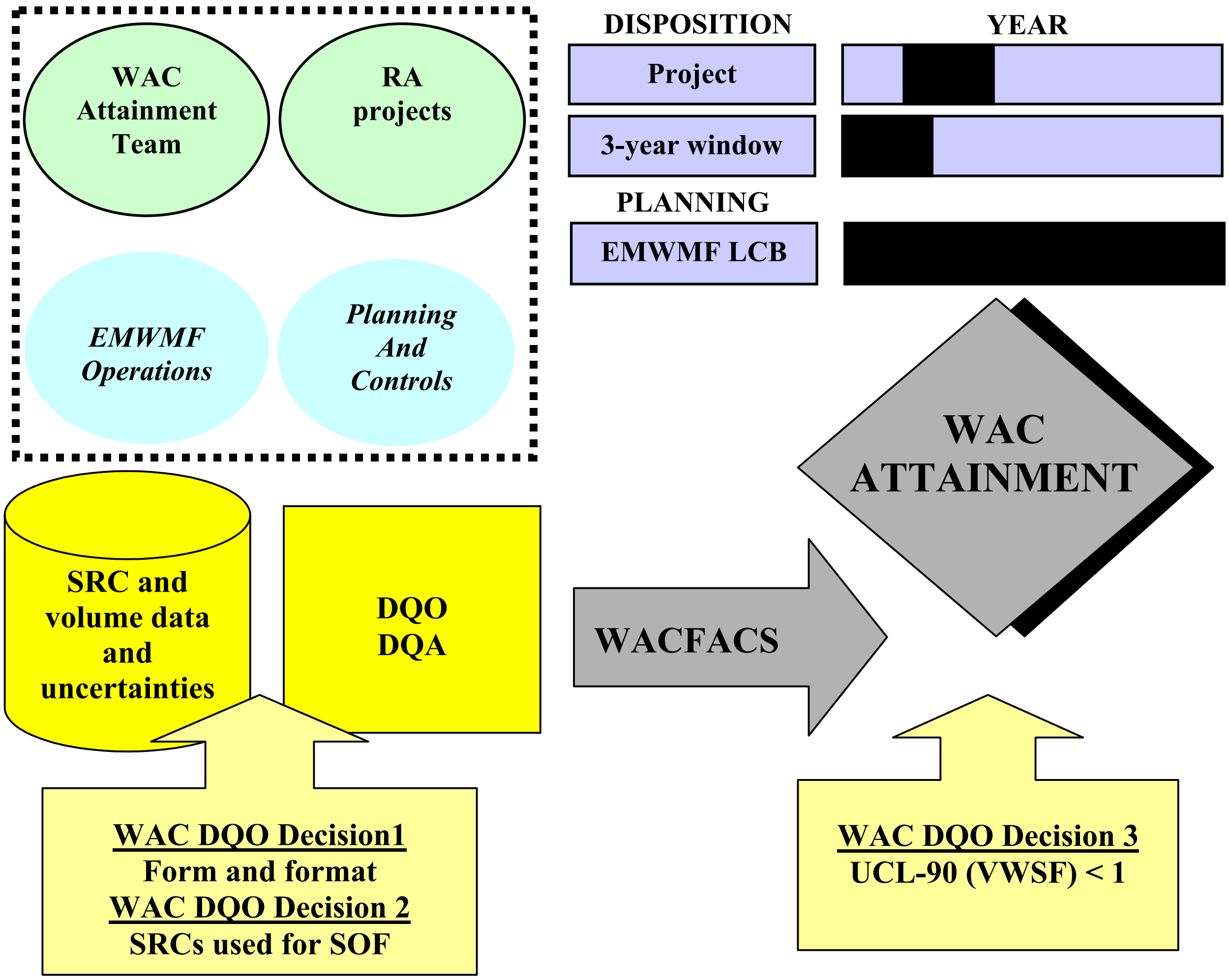


Fig. D.2 WACFACS concept of operations.

D.2 WACFACS INPUTS

This section provides a detailed discussion of input data requirements, data sources, quality assurance/data usability, and actions that must be taken to ensure that credible inputs are used in the WACFACS process. Illustrative examples of input data are provided. There are three types of data required as input to WACFACS:

- Project information
- Volume information and uncertainties
- SRC information and uncertainties

The purpose of the input data is to combine volume and SRC averages and their uncertainties to calculate SOFs and the UCL_{90} (VWSF) over time to determine if the WAC attainment DQOs are met or not met.

D.2.1 INPUT DATA REQUIREMENTS AND DATA SOURCES

Any and all data input to WACFACS must be useable and credible. Input data requirements and data sources are identified in Table D.1.

D.2.2 QUALITY ASSURANCE

Quality assurance (QA) for WACFACS inputs has two aspects: data usability and application of the DQO process/performance of DQA.

- Data usability QA ensures that inputs to WACFACS are usable and credible. Data usability guidance is performed in accordance with *EPA Region 10 Supplemental Ecological Risk Assessment Guidance for Superfund* (EPA 1997b). All WACFACS input data, prior to performance of a DQA, must meet the data quality and data usability requirements outlined in this guidance document.

- Application of the DQO process is required if additional sampling and analysis is required. DQA is performed on existing data and data collected from a DQO process. The DQA guidance is contained in *Guidance for Data Quality Assessment* (EPA 2000). This document provides general guidance on assessing data quality criteria and performance specifications for decision making. It is the culmination of experiences in the design and statistical analyses of environmental data in different program offices at EPA. The WAC Attainment Plan, Appendix C, encourages projects to follow EPA DQO, data usability, and DQA guidance to do the following:

  1. Conduct preliminary data review to learn about the structure of the data and identify patterns.
  2. Select an appropriate procedure for analyzing the data.
  3. Examine the underlying assumptions of the statistical hypothesis test.
  4. Conduct the hypothesis test and interpret the results.

Credible output from WACFACS requires project/subproject and waste management input data that have undergone a DQA using the approaches and guidance outlined in this guidance document.

Table D.1. Input data requirements and data sources

Data requirement	Data source	Comment
SRC input data (pCi/g or mg/kg)	Project or subproject databases and data sources: • OREIS • RI/FS • Pre-design data • Remedial action plan data • Process knowledge Inputs under data management configuration control and provided as part of project or subproject DQO	Data usability is performed on all SRC input data DQO-like processes to guide subsequent sampling and analysis may be applicable if SRC data gaps are present
SRC input data uncertainties	DQA performed on SRC input data Inputs under data management configuration control and provided as part of project or subproject DQO	SRC uncertainties expressed as probability function: • PERT Beta (minimum, most likely, maximum) • Normal (m = mean, SE = $s/\sqrt{n}$ = standard error of mean, RSD = Coefficient of Variation) • Lognormal (m = mean, s = standard deviation)
Volume input data (CY or yd^3)	• Project or subproject LCB WGF volumes for future wastes and waste lot volume estimates for lots under consideration LCB WGF inputs are under data management configuration control and are updated at the start of FY Q1, Q2, Q3, and Q4	Inputs are deterministic values for: • Total volume • Soil volume • Debris and other waste form volume
Volume input data confidence (-/+ %)	• Project or subproject remedial action plan Inputs under data management configuration control and provided as part of project or subproject DQO	Confidence values for LCB WGF future volumes and waste lot volumes (-/+ % of volume) are: • Low confidence (-50%, +100%) • Medium confidence (-25%, +50%) • High confidence (-10%, +15%) Uncertainties for LCB WGF (-/+ % of Total Volume) are expressed as the estimates representing a: • Very Low Value (-5%, +100%) • Very High Value(-50%, +5%)
Time Frame	Time frames of interest: • Disposition time frame for project or subproject waste lots under consideration • 3-year window • EMWMF life cycle	Time frame depends on organization element interest. Only the 3-year window VWSFs will be used to assess whether waste lots can be approved for disposal

Table D.1. Input data requirements and data sources (continued)

DQA = data quality assessment
DQO = data quality objective
EMWMF = Environmental Management Waste Management Facility
FS = feasibility study
FY = fiscal year
LCB = life cycle baseline
OREIS = Oak Ridge Environmental Information System
Q = quarter
RI = remedial investigation
SRC = site-related contaminant
WGF = Waste Generation Forecast

D.2.3 ACTIONS REQUIRED

Data inputs are obtained from either the LCB WGF or the project or subproject. Table D.2 illustrates the organizational element responsible for supplying the data input, the type of data required, and the action required by the organizational element.

Table D.2. Organizational responsibilities for data input parameters

Organization	Data input type	Action required
Project or subproject	SRC input data (pCi/g or mg/kg)	Maintain data management configuration control Obtain SRC values Identify data gaps
Project or subproject	SRC input data uncertainties (μ, σ^2, or Coefficient of Variation)	Maintain data management configuration control Determine statistical distribution function for SRC data including parameters (μ, σ^2)
LCB WGF	Volume input data (CY or yd^3)	Maintain data management configuration control to ensure WACFACS data is consistent with LCB WGF Provide data at start of FY Q1, Q2, Q3, and Q4
Project or subproject	Volume input data confidence (-/+ %)	Maintain data management configuration control Determine confidence values
Organizational elements	Time frame	Confirm time frame of interest

FY = fiscal year
LCB = life cycle baseline
Q = quarter
SRC = site-related contaminant
WACFACS = Waste Acceptance Criteria Forecasting Analysis Capability System
WGF = Waste Generation Forecast

D.2.4 INPUT DATA SHEETS

Figure D.3 presents the "WACFACS Data Input Worksheet." These worksheets are used by the project or subproject to define input data for WACFACS use. There are several types of data input requirements on the worksheets. (Note that some of the worksheets have output fields; this is a design characteristic of the worksheet to offer feedback for data entry and refinement.). The data input requirements are as follows:

- General project or subproject information to include the project or subproject name and the WACFACS point of contact.

- Project or subproject schedule information to include waste disposition time periods.

- SRC input data to include identification of SRCs and usability and DQA based estimates for the mean, the variance, the coefficient of variation, the minimum and maximum values, and the probability functions each SRC follows.

- Volume input data to include identification of total volume, waste material volumes, confidence in volume estimates, and waste lot disposition information.

SUBPROJECT INFORMATION

Input	Output	Fixed

PID

SUBPROJECT NAME	Project Name
POC Name	POC
POC Email	pci@bechteljacobs.org
POC Telephone	865 555 1212

SCHEDULE INFORMATION

DISPOSITION

		Units	Criteria
Start Date	04/01/2002	mm-dd-yyyy	
Start Quarter	3	Start of Quarter	1, 2, 3, or 4
Start FY	2	Fiscal Year	2, 3, 4, …, 10

End Date	06/30/2002	mm-dd-yyyy	
End Quarter	3	End of Quarter	1, 2, 3, or 4 AND > Disposition Start Quarter
End FY	2	Fiscal Year	2, 3, 4, …, 10 AND ≥ Dispostion Start FY

Duration 1.0 **Quarters**

Quarter	Months
1	10, 11, 12
2	1, 2, 3
3	4, 5, 6
4	7, 8, 9

Project Disposition Duration

Comments	Comments

Fig. D.3. WACFACS data input worksheet.

WASTE VOLUME INFORMATION
BYBY

Input	Output	Fixed	WACFACS

Project Annual Volume from LCB WGF

TOTAL VOLUME	Volume
Total WGF Volume (CY)	38,000

Material Type	FY02	FY03	FY04	FY05	FY06	FY07	FY08	FY09	FY10
Soil	38,000	0	0	0	0	0	0	0	0
Debris	0	0	0	0	0	0	0	0	0
Total	38,000	0	0	0	0	0	0	0	0

Confidence in Project Annual Volume Estimate

Material Type	CIVV INPUT	Expected CY	Total %
Soil	h	38,317	100%
Debris	L	0	0%
Total		38,317	100%

DO NOT ALTER THESE FIXED VALUES

Confidence in Volume Value (CIVV)	INPUT	MIN %	MAX %
The Confidence in the Volume value is LOW	L	-50%	100%
The Confidence in the Volume value is MODERATE	M	-25%	50%
The Confidence in the Volume value is HIGH	H	-10%	15%
The Volume value is really VERY LOW	VL	-5%	100%
The Volume value is really VERY HIGH	VH	-50%	5%

Identify Waste Lots, Volume, and Schedule

Waste Lots	Soil	Debris	Total	Disposal Start Quarter	Disposal Start Year	Disposal End Quarter	Disposal End Year
Name 1	38,000	0	38,000	3	2002	3	2002
Name 2	0	0	0				
Name 3	0	0	0				
Name 4	0	0	0				
Name 5	0	0	0				
Name 6	0	0	0				
	38,000	0	38,000				

Comments | Comments

Fig. D.3 (continued)

Identify Waste Lot Volume by FY and Quarter

WASTE VOLUME INFORMATION
BYBY

Input	Output	Fixed	WACFACS

ENTER 0 IN THE FYnn Qn THE EMWMF IS OPERATIONAL
ENTER 0 IN THE FYnn Qn THE QUARTER THE FIRST WASTE LOT IS DISPOSED AT EMWMF
WASTE LOT VOLUME VALUES FROM ABOVE TABLE

FY02 - FY04	FY02				FY03				FY04
Soil	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1
EMWMF Quarter		0	3	6	9	12	15	18	21
Project Quarter		0	3						
Name 1	0	38,317	0	0	0	0	0	0	0
Name 2	0	0	0	0	0	0	0	0	0
Name 3	0	0	0	0	0	0	0	0	0
Name 4	0	0	0	0	0	0	0	0	0
Name 5	0	0	0	0	0	0	0	0	0
Name 6	0	0	0	0	0	0	0	0	0
Total	0	38,317	0	0	0	0	0	0	0

List of WAC SRC

SOF CALCULATIONS - 1
BYBY

Input	Output	Fixed	WACFACS

Which SRC should be combined?

ID	SRC	Units	Combine this SRC with SRC ID#	Combined DATA	Data Entry Required
1	Am-241	pCi/g			
2	C-14	pCi/g			
3	H-3	pCi/g			
4	I-129	pCi/g			
5	Np-237	pCi/g			
6	Pu-239	pCi/g	6	Pu 239/240	Yes
7	Pu-240	pCi/g			
8	Tc-99	pCi/g			
9	U-233	pCi/g			
10	U-234	pCi/g	10	U-233/234	Yes
11	U-235	pCi/g			
12	U-236	pCi/g			
13	U-238	pCi/g			
14	Antimony	mg/kg			
⋮					
34	Tetrachloroethene	mg/kg			
35	Toluene	mg/kg			
36	Trichloroethene	mg/kg			

Fig. D.3 (continued)

DQA defines Probability Function

Identify need for additional data

SOF CALCULATIONS - 2
BYBY

Input	Output	Fixed	WACFACS

ID	SRC	Units	SRC? Y/N/?	Missing Data? Y/N	Data Entry Required	Enter 1 in the Column for PDF Normal PDF	Lognormal PDF	PERT Beta PDF	Error Check
1	Am-241	pCi/g	Y	N	Yes			1	
2	C-14	pCi/g	N	N					
3	H-3	pCi/g	Y	N	Yes	1			
4	I-129	pCi/g	N	N					
5	Np-237	pCi/g	Y	N	Yes			1	
6	Pu-239	pCi/g							
7	Pu 239/240	pCi/g	Y	N	Yes		1		
8	Tc-99	pCi/g	Y	N	Yes			1	
9	U-233	pCi/g							
10	U-233/234	pCi/g	Y	N	Yes		1		
11	U-235	pCi/g	Y	N	Yes		1		
12	U-236	pCi/g	Y	N	Yes			1	
13	U-238	pCi/g	Y	N	Yes		1		
14	Antimony	mg/kg	?	Y					Collect Data
34	Tetrachloroethene	mg/kg	Y	N	Yes			1	
35	Toluene	mg/kg	Y	N	Yes			1	
36	Trichloroethene	mg/kg	Y	N	Yes			1	

(Note: SOF Calculations -3 worksheet is for SRC data that follows a Normal distribution, and SOF Calculations-5 worksheet is for SRC data that follows a PERT/Beta distribution.)

Parameters of Probability Function

WACFACS Calculation

Real-time SOF Calculation

SOF CALCULATIONS - 4
BYBY

Input	Output	Fixed	WACFACS

ID	SRC	PDF	Lognormal Mean	Lognormal SD	Number of Detects
1	Am-241				
2	C-14				
3	H-3				
4	I-129				
5	Np-237				
6	Pu-239				
7	Pu 239/240	LN	-2.743	1.0310	19
8	Tc-99				
9	U-233				
10	U-233/234	LN	5.272	0.9460	18
11	U-235	LN	2.348	1.1020	18
12	U-236				
13	U-238	LN	5.622	1.3900	17
14	Antimony				
34	Tetrachloroethene				
35	Toluene				
36	Trichloroethene				

	0.488	0.797
WACFACS	HQ WAC	Cancer WAC
	0.00E+00	0.00E+00
	0.00E+00	0.00E+00
	0.00E+00	0.00E+00
	0.00E+00	0.00E+00
	0.00E+00	0.00E+00
	0.00E+00	0.00E+00
0.11	0.00E+00	1.89E-05
	0.00E+00	0.00E+00
	0.00E+00	0.00E+00
304.74	1.09E-05	1.79E-01
19.21	2.02E-03	1.28E-02
	0.00E+00	0.00E+00
726.36	4.84E-01	6.05E-01
	0.00E+00	0.00E+00
	0.00E+00	0.00E+00
	0.00E+00	0.00E+00
	0.00E+00	0.00E+00

Fig. D.3 (continued)

Volume input data are supplied from the LCB WGF. Data inputs are deterministic values for total volume, soil volume, and debris and other waste form volume. WACFACS requires up-to-date WGF information with a quarterly time domain for WGF data management configuration control (i.e., for WACFACS purposes, downloaded WGF data will be under configuration control at the start of each fiscal year first quarter, second quarter, third quarter, and fourth quarter). Only subproject worksheets with "Destination: ORR-EMWMF Data Only" are used. Figure D.4 illustrates the influence of uncertainties on expected volumes and on SRCs.

SRC input data are obtained from the OREIS database and from RI/FS data, predesign data, remedial action plan data, and process knowledge data sources. SRC input data uncertainties are computed using DQA techniques based upon data usability and applicable DQO. Data are provided from SRC-1 through SRC-4 sections of the WACFACS Data Input Worksheet. Figure D.4 illustrates the effect of volume uncertainties on a hypothetical WGF volume value of 10,000 yd^3. If a project has "High" confidence in the volume estimate, the top portion of the figure describes the volume probability function. If the project believes the volume estimate is "Very High," the lower portion of the figure illustrates the probability function. Figure D.5 illustrates the influence of uncertainties on an SRC with a most likely value of 100 pCi/g. The upper and lower portions of the figure illustrate the cases of the maximum uncertainty value being 1500 pCi/g and 4500 pCi/g, respectively.

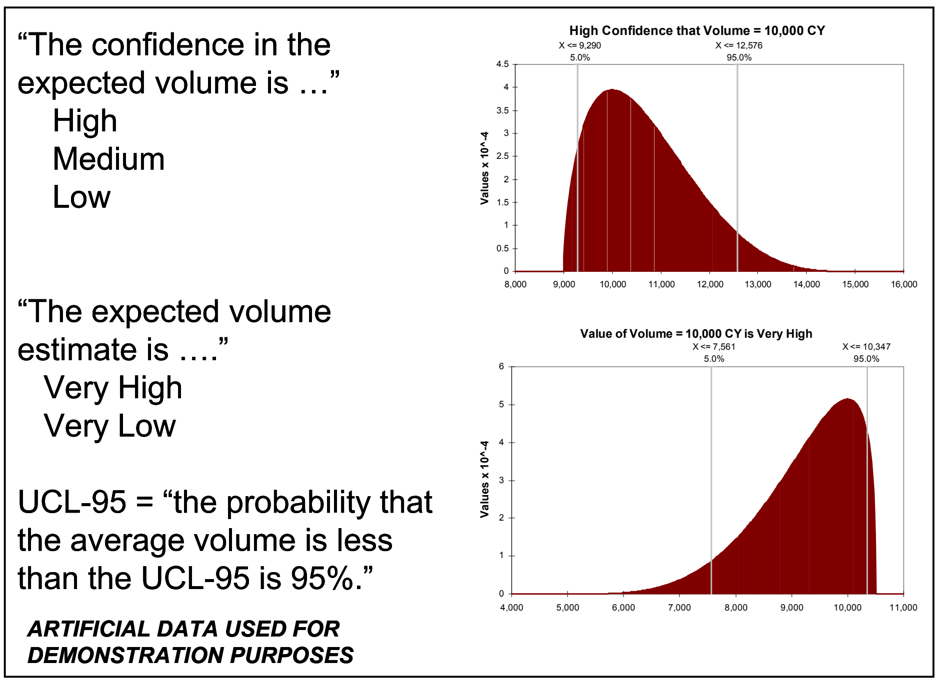


Fig. D.4. WACFACS captures uncertainties on volumes.

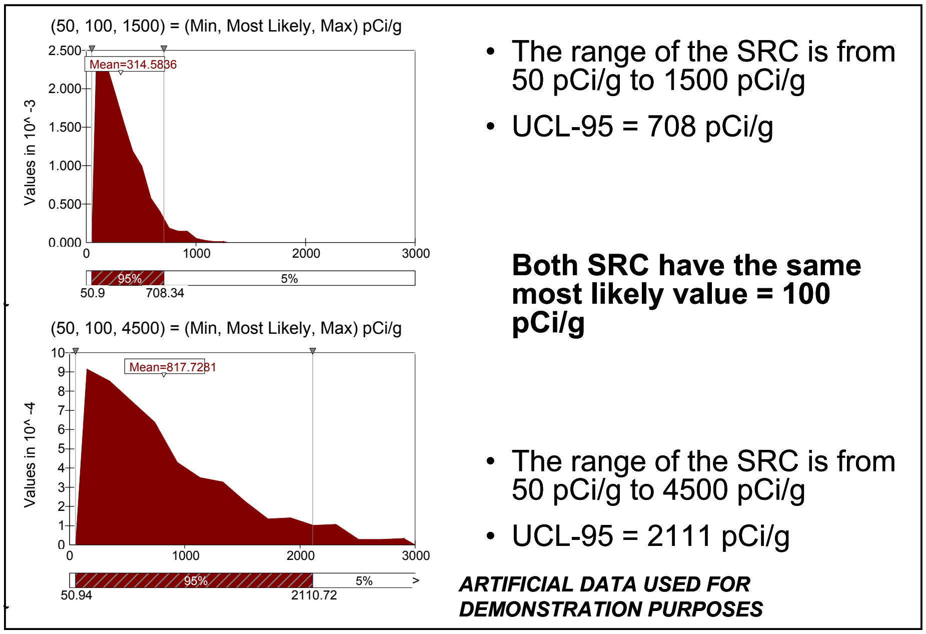


Fig. D.5. WACFACS captures uncertainties on SRCs.

D.3 WACFACS OUTPUTS

This section presents the form and format of the WACFACS measures used to address the WAC attainment DQO. The following outputs are provided by WACFACS:

- VWSF and UCL_{90} (VWSF)
- Soil-to-debris ratio

D.3.1 WACFACS OUTPUT CALCULATIONS

The following formulas are used to compute the outputs:

$$SOF = \sum_i \frac{C_i}{WAC_i}$$

where:

- C_i = the average concentration of contaminant i,
- WAC_i = the analytic WAC for contaminant i.

$$VWSF = \frac{1}{V_{tot}} \sum_j SOF_j V_j$$

where:

- SOF_j = the sum of fractions for waste lot j,
- V_j = the volume of waste lot j,
- V_{tot} = the total of in-cell volumes and the 3-year projection from the WGF of volumes to be placed in the EMWMF (other time frames can be used for planning purposes)

D.3.2 WACFACS OUTPUTS

Table D.4 is the summary output of WACFACS. There are several key elements of the output. This is a key output used by the WAC Attainment Team to evaluate a project UCL_{90} (VWSF) and to examine the quarterly total UCL_{90} (VWSF).

- The user picks the time frame of interest, and, from this, WACFACS computes the UCL_{90} (VWSF). This is accomplished for each waste lot for each project.

- The expected VWSF for the hazard index (HI) and the carcinogenic WAC is computed on a quarterly basis for the 3-year window and on an annual basis for the LCB planning horizon for all projects.

Table D.3. WACFACS VWSF output

VWSF SUMMARY

Input	Output	Fixed	WACFACS

Project Name

Project Name	38,317	CY

Waste Lot	Name 1	Name 2	Name 3	Name 4	Name 5	Name 6
Expected Volume/Waste Lot	38,317	0	0	0	0	0
Soil to Debris Ratio	Maximum	0.0	0.0	0.0	0.0	0.0

SOF HI	1.13
SOF Carcinogenic	1.69

Timeframes and Volumes	Total CY	% of Total	Enter Y or leave blank Choice = Y
FY02- FY04 Expected Total Volume	348,000	11%	Y
Life Cycle	1,800,000	2%	
Running Total Volume	0	100%	
Project Volume	38,317	100%	

VWSF of Interest	Expected Value		WACFACS UCL$_{90}$ VWSF
Three Year Window			
Project Name VWSF HI 348 K CY	0.12	VWSF of Interest	
Project Name VWSF Carcinogenic 348 K CY	0.19	VWSF of Interest	
Life Cycle			
Project Name VWSF HI 1.8 M CY	0.02		
Project Name VWSF Carcinogenic 1.8 K CY	0.04		
Accumulation Assessment			
Project Name VWSF HI 38.3 K CY	1.13		
Project Name VWSF Carcinogenic 38.3 K CY	1.69		
Project SOF			
Project Name VWSF HI 38 K CY	1.13		
Project Name VWSF Carcinogenic 38 K CY	1.69		

Table D.3. WACFACS VWSF output (continued)

HI WAC VWSF													Total
FY02 - FY04	FY02	FY02	FY02	FY02	FY03	FY03	FY03	FY03	FY04	FY04	FY04	FY04	FY02-FY04
348K CY	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	
EMWMF Quarter		0	3	6	9	12	15	18	21	24	27	30	
Project Quarter		0	3										
Name 1	0.00	0.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Name 2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Name 3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Name 4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Name 5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Name 6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	0.00	0.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Carcinogenic WAC VWSF													Total
FY02 - FY04	FY02	FY02	FY02	FY02	FY03	FY03	FY03	FY03	FY04	FY04	FY04	FY04	
348K CY	Q1	Q2	Q3	12	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	FY02-FY04
EMWMF Quarter		0	3	6	9	12	15	18	21	24	27	30	
Project Quarter		0	3										
Name 1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Name 2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Name 3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Name 4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Name 5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Name 6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table D.3. WACFACS VWSF output (concluded)

HI WAC VWSF							Total
FY05 - FY10	FY05	FY06	FY07	FY08	FY09	FY10	FY05 - FY10
348K CY							
EMWMF Quarter	48	60	72	84	96	108	
Project Quarter							
Name 1	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Name 2	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Name 3	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Name 4	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Name 5	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Name 6	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Carcinogenic WAC VWSF							Total
FY05 - FY10	FY05	FY06	FY07	FY08	FY09	FY10	FY05 - FY10
348K CY							
EMWMF Quarter	48	60	72	84	96	108	
Project Quarter							
Name 1	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Name 2	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Name 3	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Name 4	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Name 5	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Name 6	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	0.00	0.00	0.00	0.00	0.00	0.00	0.00

D.3.2.1 SOF Distributions and UCL_{95}

SOF distributions and UCL_{95} values are computed rapidly by WACFACS. The general form of the SOF distribution propagates the uncertainty of all SRC distributions to generate a final SOF distribution. An example of SOF output is as follows:

- SOF for the HI WAC for Project P and the Key SRC, Fig. D.6. The expected project HI SOF is computed as 1.38. The UCL_{95} is 3.02. The key SRCs driving the SOF for the HI WAC are ^{238}U and Pb. Reducing the variability of ^{238}U by 0.895 reduces the SOF by the same amount.

- SOF for the carcinogenic WAC for Project P and the Key SRC, Fig. D.7. The expected project carcinogenic SOF is computed as 1.95. The UCL_{95} is 3.59. The key SRCs driving the SOF for the carcinogenic WAC are ^{238}U, ^{99}Tc, and Pb. Reducing the variability of ^{238}U by 0.968 reduces the SOF by the same amount.

These are excessively large SOF values. Given an understanding of the variability of the SRC (due primarily to ^{238}U), the data could be re-examined to determine if significant outliers (for whatever reason) were included. If this were not the case, the DQO process and sampling and analysis would be accomplished. The number of samples required would be a function of the very large variability in ^{238}U.

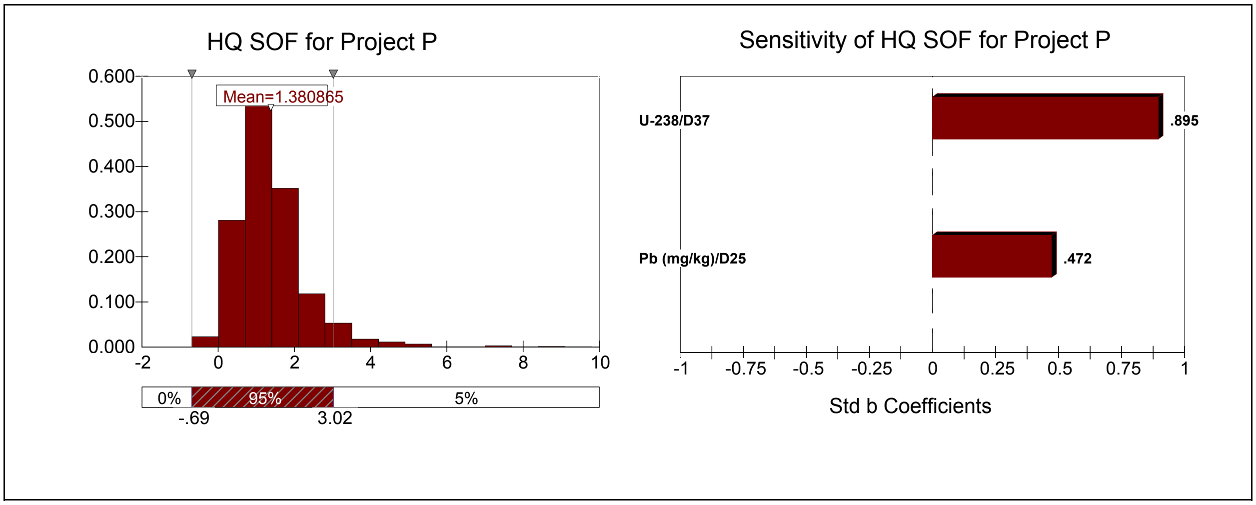


Fig. D.6 SOF for the HI WAC for Project P and sensitivity.

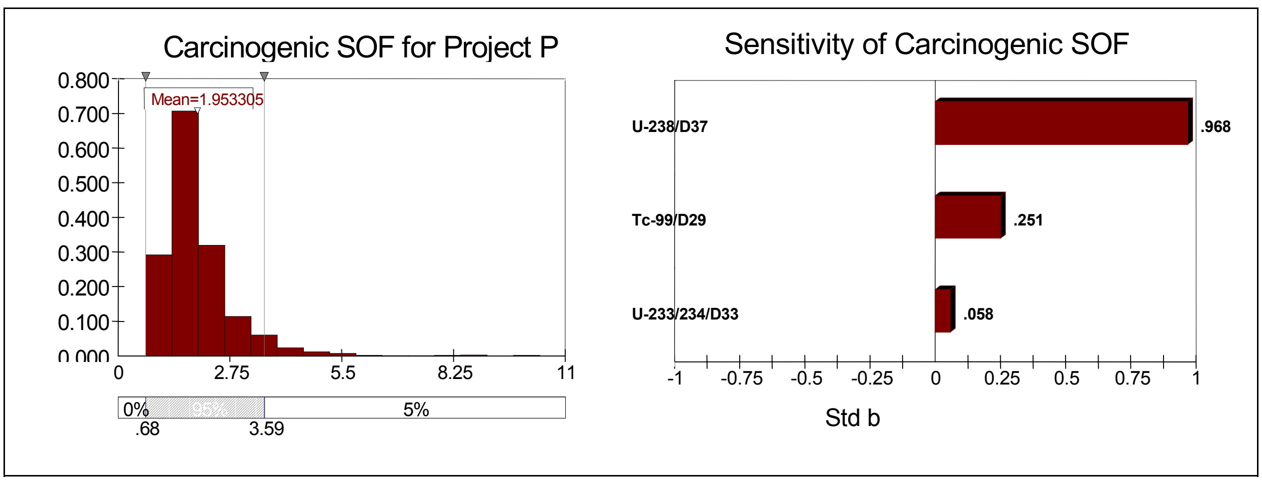


Fig. D.7. SOF for the carcinogenic WAC for Project P and sensitivity.

D.3.3 VWSF DISTRIBUTIONS AND UCL_{90}

VWSF distributions and UCL_{90} values are also rapidly computed by WACFACS. The general form of the VWSF distribution propagates the uncertainty of all SOF distributions and volume distributions to generate a final VWSF distribution. In addition, WACFACS performs a sensitivity analysis to determine the key VWSF uncertainty drivers. The following examples illustrate VWSF outputs and sensitivity analysis outputs.

Figure D.8 illustrates an example output for the HI WAC VWSF for Project P and the key uncertainty drivers for this VWSF. The expected project HI VWSF is computed as 0.0003 when the project volume is 4,166 yd^3. The UCL_{90} is 0.0007. The key SRCs driving the VWSF for the HI WAC are ^{238}U and Pb and the volume.

VWSF for the carcinogenic WAC for Project P and the Key SRC are shown in Fig. D.9. The expected project carcinogenic VWSF is computed as 0.0045 with a UCL_{90} of 0.0084. The key uncertainty drivers for the carcinogenic WAC VWSF are ^{238}U, ^{99}Tc, and Pb concentrations.

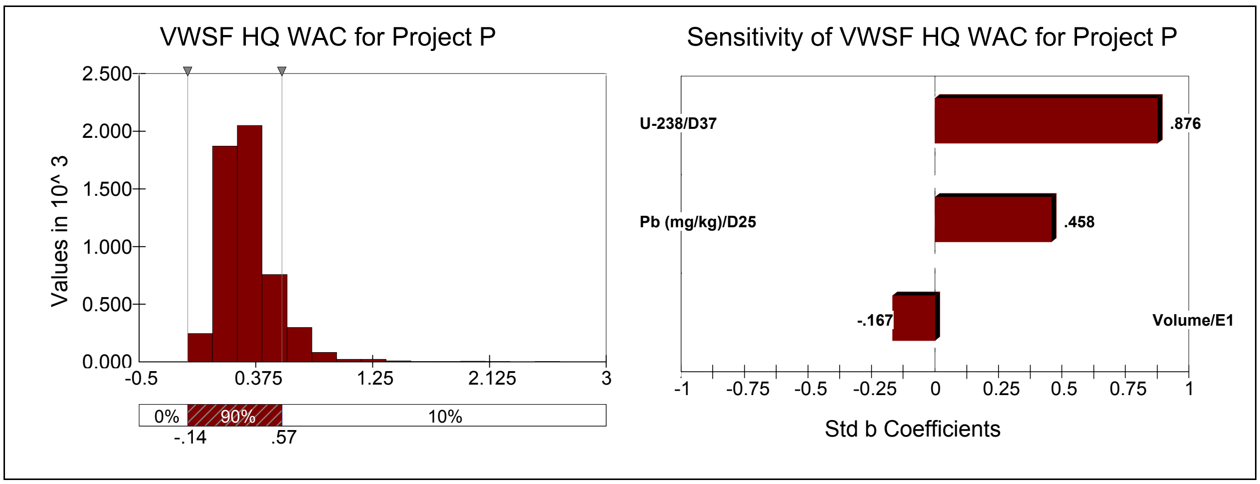


Fig. D.8. VWSF for the HI WAC for Project P and sensitivity.

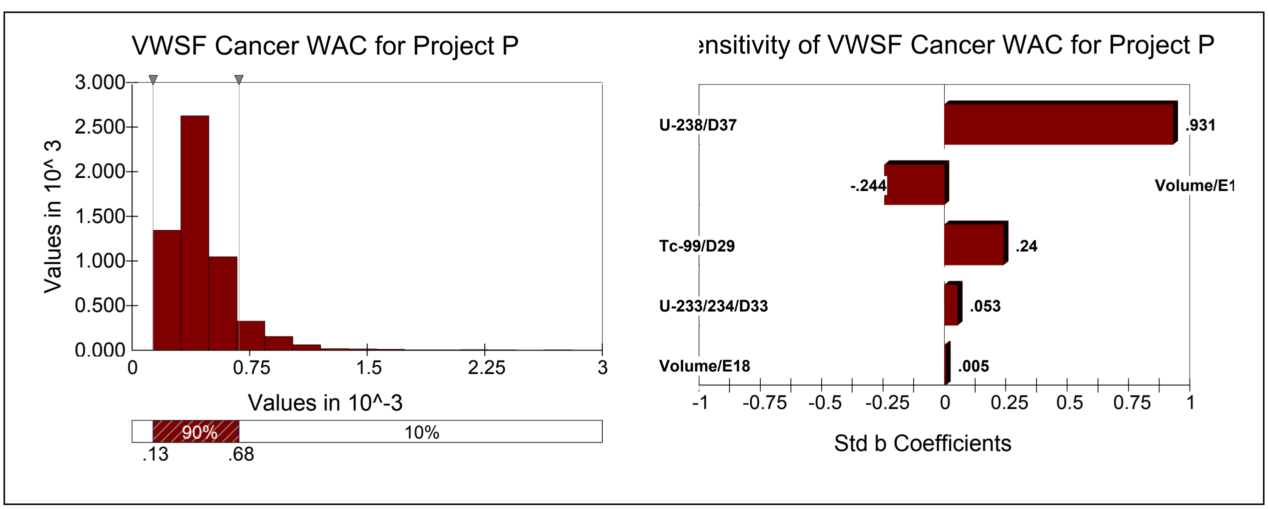
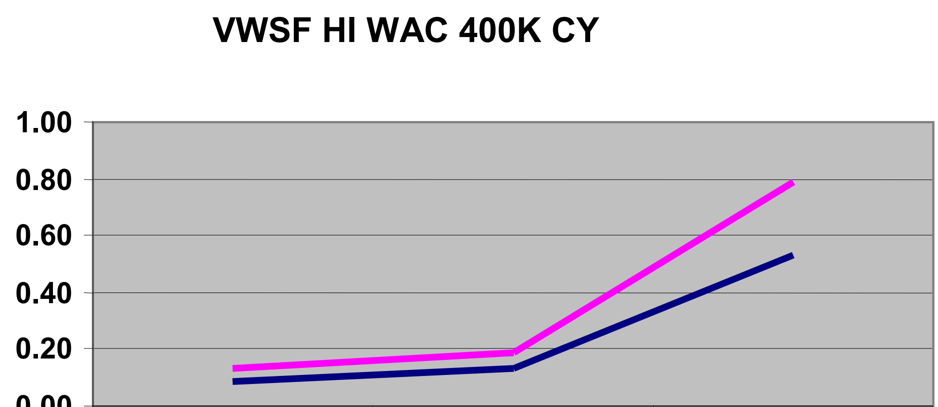


Fig. D.9. VWSF for the carcinogenic WAC for Project P and sensitivity.

D.3.3.1 Annual Output

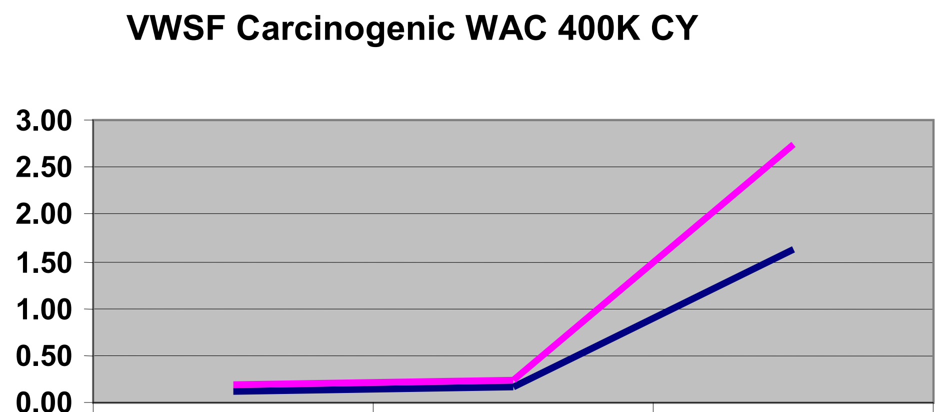
Examining annual output, it is possible to see the annual and cumulative VWSF for each WAC. Figures D.10 and D.11 illustrate this a 3-year window. All data, including the 400,000 yd^3 volume assumption, is hypothetical in nature and is used for illustrative purposes only. WACFACS rapidly identifies when VWSF and UCL_{90} (VWSF) approaches or exceeds 1, and provides the primary tools necessary to manage the VWSF and its uncertainty to guarantee that the UCL_{90} (VWSF) is less than 1.

In the following examples, the UCL_{90} (VWSF) for the HI WAC is shown to be less than 1, indicating that the wastes are acceptable from the perspective of this analytic WAC requirement. However, the UCL_{90} (VWSF) of the carcinogenic WAC is seen to rise above 1 in FY+2. This would indicate that one or more waste lots in that year require re-examination to determine whether it is correct to assume that they would be disposed in the EMWMF as proposed. WACFACS would be used to identify not only the waste lots whose SOF values are causing the rise in the expected VWSF value, but also those with the SOF uncertainties that are contributing most of the uncertainty in the UCL_{90} (VWSF) value. Once those waste lots are identified, the RA projects scheduled to generate those lots would be queried to examine options to deal with their high SOF values and uncertainties. These evaluations may determine that additional data are needed to refine the estimates of the third-year VWSF, or that part or all of certain waste lots cannot be disposed in the EMWMF as proposed.



	Current FY	FY+1	FY+2
VWSF	0.08	0.14	0.53
UCL-90	0.13	0.19	0.79

Fig. D.10. Annual VWSF for the HI WAC for a 3-year window (400K CY EMWMF).



	Current FY	FY+1	FY+2
VWSF	0.12	0.17	1.64
UCL-90	0.18	0.24	2.74

Fig. D.11. Annual VWSF for the carcinogenic WAC for a 3-year window (400K CY EMWMF).

D.4 WACFACS PROCESS

The MCA probabilistic technique is summarized briefly. The manner in which WACFACS deals with data management, uncertainty management, and sensitivity management is presented.

D.4.1 MCA PROBABILISTIC TECHNIQUE

The MCA probabilistic technique is presented in Fig. D.12. MCA is a random sampling technique that makes random draws from each of the probability functions. For example, in Fig. D.12, a random value from each of the SRC concentrations is selected (as defined by SRC variability in the WACFACS Inputs), and the SOF is computed for that concentration. This is performed for all SRC in excess of 10,000 times, and this represents a “resampling” of the SRC analytic input data. The same process is accomplished for the volume data (as defined by volume variability in the WACFACS Inputs). From this the product of the project volume and the project SOF is computed. Dividing this by the volume of interest (dependent upon the planning horizon) allows for calculation of the VWSF and the UCL_{90} (VWSF).

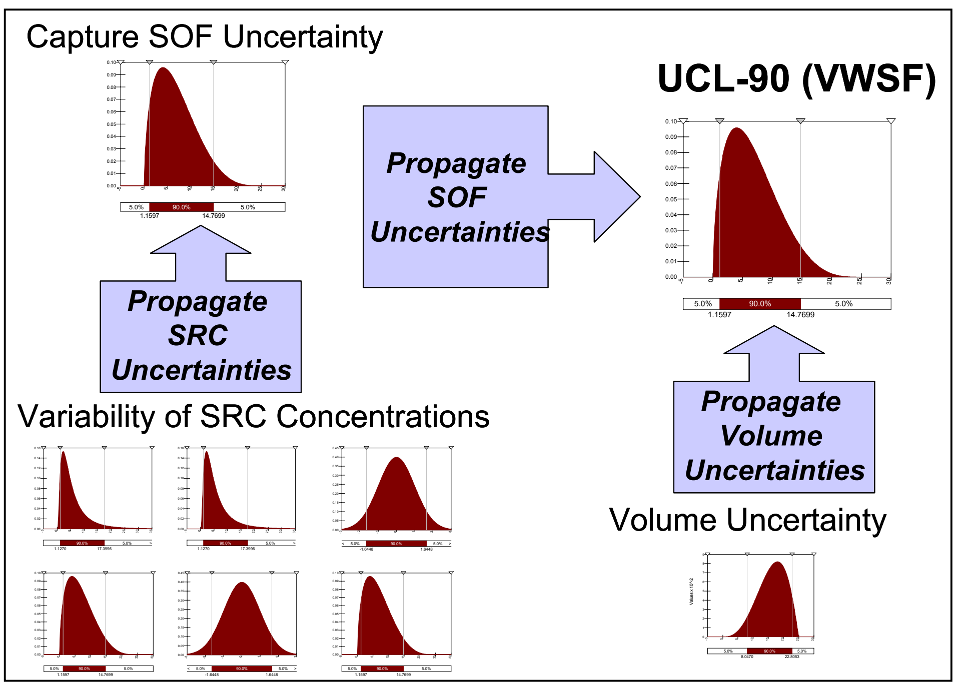


Fig. D.12. The WACFACS MCA probabilistic technique.

D.4.2 WACFACS OUTPUT ANALYSIS

Table D.5 identifies the actions that are performed when WACFACS is utilized in the areas of data management, uncertainty management, and sensitivity management. Data management deals primarily with ensuring the data are usable by WACFACS. Uncertainty management and sensitivity management address what key variables drive the UCL_{90} (VWSF).

Table D.5. Actions performed when WACFACS is utilized

Topical area Action or investigation area	Data management	Uncertainty management	Sensitivity management
Perform DQO, data usability, and DQA	•	•	•
Identify need for additional sampling and analysis	•	•	•
Identify/evaluate alternate sequencing of projects		•	•
Identify/evaluate alternative waste lots		•	•
Identify/evaluate SRCs that drive SOF and VWSF		•	•
Identify/evaluate projects that drive SOF and VWSF		•	•
Identify upgrades to EMWMF to support fixed levels of UCL_{90} (VWSF)		•	•

DQA = data quality assessment
DQO = data quality objective
EMWMF = Environmental Management Waste Management Facility
SOF = sum of fractions
SRC = site-related contaminant
UCL_{90} = 90% upper confidence limit
VWSF = volume-weighted sum of fractions
WACFACS = Waste Acceptance Criteria Forecasting Analysis Capability System

The list of actions or investigations is necessarily incomplete. The flexibility of WACFACS lies in its ability to address such issues in a real-time mode, and this reinforces the power of the tool for effective WAC attainment. Such actions or investigations of VWSF forecasting and analysis of uncertainties supports short-term and strategic decisions and alternatives analyses.

D.5 REFERENCES

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APPENDIX E

WASTE ACCEPTANCE CRITERIA DATA QUALITY OBJECTIVES FOR ENVIRONMENTAL MANAGEMENT WASTE MANAGEMENT FACILITY

E.1 INTRODUCTION

This appendix presents the data quality objectives (DQOs) for meeting the Environmental Management Waste Management Facility (EMWMF) waste acceptance criteria (WAC) and WAC Attainment Team requirements.

The EMWMF DQOs are referred to as the DQO Decisions. All DQO Decisions have been agreed to by the U.S. Environmental Protection Agency (EPA), the Tennessee Department of Environmental Conservation (TDEC), and the U.S. Department of Energy (DOE) Oak Ridge Operations (ORO).

Oak Ridge Reservation (ORR) response action (RA) projects intend to use the EMWMF. In support of this goal, the DQO Decisions address the following questions:

- DQO Decision 1: Does the waste lot data meet the form and format required by the WAC Attainment Team?
- DQO Decision 2: Is the existing waste lot characterization data sufficient to assess the waste lot sums of fractions (SOFs)?
- DQO Decision 3: Using a graded approach for the effects of SOF uncertainties on the volume-weighted sums of fractions (VWSFs), can the waste stream be disposed at the EMWMF?

The DQO Decisions are applicable whenever an RA project has interest in using the EMWMF as the on-site disposal location for waste lots generated by the RA project. Using the DQO Decisions, the EMWMF WAC Attainment Team can utilize waste lot analytical data to do the following:

- Accurately assess waste lot SOFs and the EMWMF VWSFs,
- Examine significant parameters of future EMWMF waste streams with those of EMWMF-disposed waste to forecast the VWSF at various times in the future, and
- Perform sensitivity analysis to identify critical future waste streams impacting the VWSF.

The WAC Attainment Team will apply these DQO Decisions in order to determine whether individual waste lots can be accepted as proposed, or whether additional information or waste lot modifications will be required for acceptance. As the operations of the EMWMF mature, requirements for waste lots may change. As such, the DQO Decisions may need to be refined. The WAC Attainment Team will make additions, refinements, or deletions to DQO Decisions on an annual basis, if approved by the Federal Facility Agreement parties.

This appendix is structured along the lines of the DQO steps performed to reach consensus on key decisions. The statement of the problem documents the results of applying the first step of the DQO Process, "State the Problem." This allowed EPA, TDEC, and DOE to visualize the multiple facets of the problem. The agreed-upon problem statement summarizes the stakeholder perspectives.

The key decisions applicable to the problem statement are then discussed. This section contains the results of DQO Step 2, "Identify Key Decisions." Each decision is presented in the following manner.

1. Purpose of the decision (why we need the data)

2. Inputs to the decision (what the data must represent and how they will be used)
3. Tolerable limits on decision errors (How much uncertainty is tolerable)

The Key Decisions section concludes with a summary of the results of DQO Step 4, “Define the Boundaries of the Study.”

The decision logic is discussed in a stand-alone section. One of the most valuable products of the DQO process is derived during Step 5, “Develop a Decision Rule.” The DQO decision logic summarizes the attributes of the problem and how the information collected will allow the selection of primary and alternate courses of action to solve the problem. Noted in this section is that RA projects are responsible for accomplishing DQO Process Step 7, “Optimize the Design” by developing plans to meet WAC Attainment Team risk and confidence criteria. Thus, for the DQO Decisions, Step 7 is not required.

The Conclusions section summarizes the results obtained from the DQO Decisions Process workshops.

An annotated glossary of DQO terms is also provided as Attachment E-1.

E.2 BACKGROUND

DOE recognized that quantifying risk and toxicity-based EMWMF performance criteria prescribed in the WAC Attainment Plan could be effectively accomplished in a DQO workshop setting with EPA, TDEC, and DOE. Two workshops were scheduled and complete during August and September 2000. The technical approach is presented in Fig. E.1.

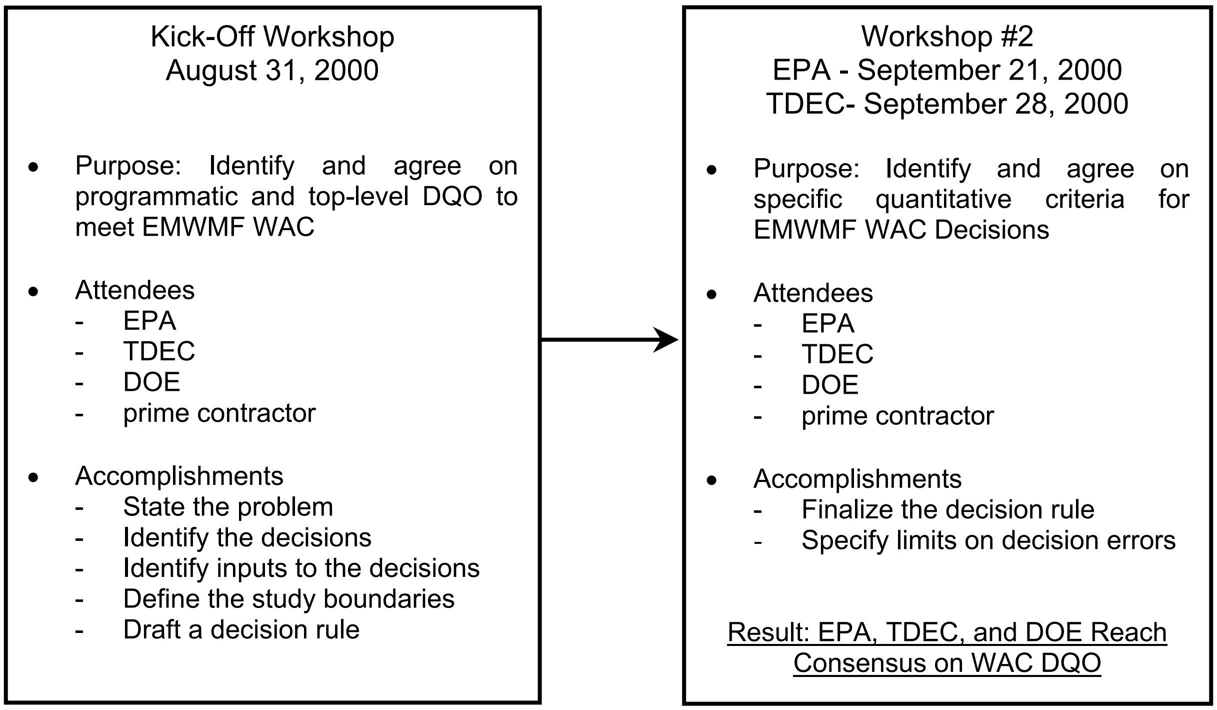

Fig. E.1. Technical approach for DQO Decisions Workshop.

The DQO process is a formal process used in environmental problems. It has been successfully used for many projects at the ORR. Formal documentation of the DQO Process is presented in “Guidance for the Data Quality Objectives Process” (EPA 2000).

The purpose of using the DQO process is to answer four fundamental questions:

1. Why do we need data?
2. What must the data represent?
3. How will we use the data?
4. How much uncertainty is tolerable?

The DQO process is summarized in Fig. E.2.

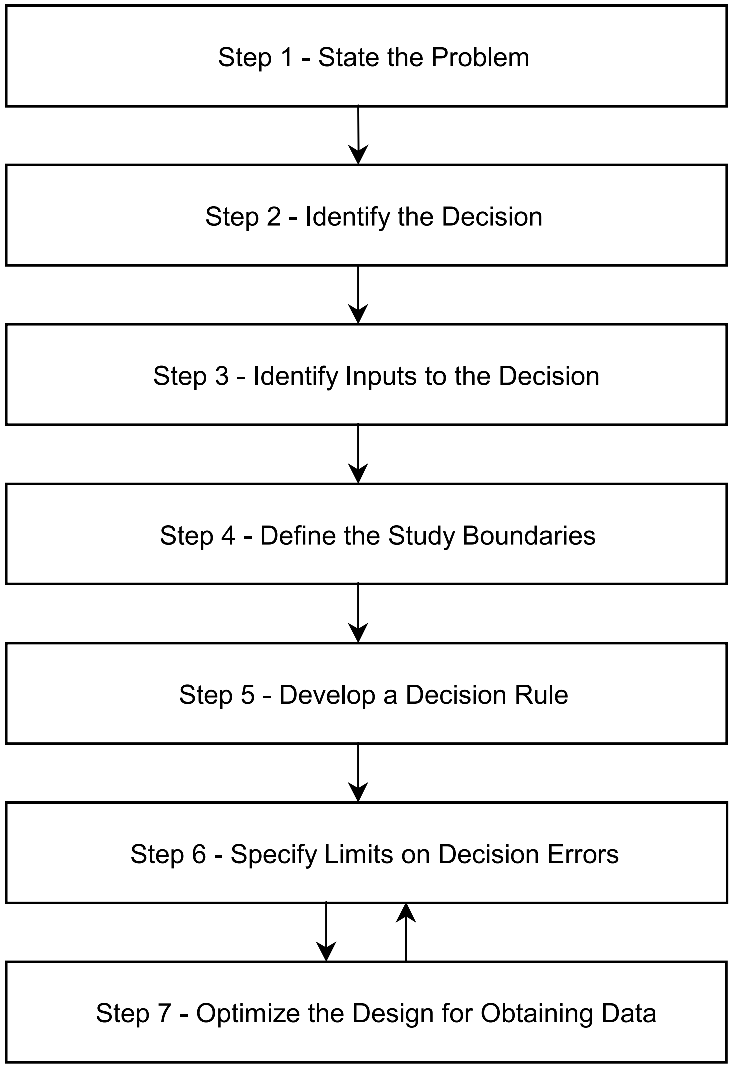

Fig. E.2. Steps of the DQO process.

After the conclusion of the DQO workshops, a WAC attainment plan was drafted and submitted to the regulators for comment. Based upon feedback from the regulators, the original DQO Decision statements were modified to clarify their intent. However, the basic agreements reached in the DQO workshops, including the specific statistical goals to use in achieving each DQO Decision, have not been changed.

E.3 STATEMENT OF THE PROBLEM

EPA, TDEC, and DOE agreed on the key issue facing the WAC Attainment Team for each waste lot wishing to use the EMWMF:

> "Under the EMWMF ROD, the volume weighted sum of fractions (VWSF) at closure must be, on the average, at or below a threshold (<1) to demonstrate we meet the Remedial Action Objectives (RAO)."

Under the first step of the DQO Process, the issue facing the WAC Attainment Team is denoted as the "State the Problem." Since EPA, TDEC, and DOE agreed the above-stated formulation of the problem needed to be addressed by the WAC Attainment Team, the stage was set for accomplishing the remaining DQO steps.

EPA, TDEC, and DOE agreed the following ground rules were needed to address the issue:

- The regulatory driver is the EMWMF ROD
- The key stakeholders are EPA Region 4, TDEC, and DOE ORO, including the prime contractor as DOE's management and integration contractor,
- The EMWMF WAC life cycle is FY02–FY11+,
- The WAC Attainment Team will use a 3-year forecast of wastes coming to the EMWMF to determine whether waste lots with an SOF greater than 1 can be accepted on the basis of the VWSF being less than 1, and
- The Waste Generation Forecast is the source data for waste lot and RA project volume estimates that are disposed at the EMWMF.

E.4 KEY DECISIONS

EPA, TDEC, and DOE agreed there are three key decisions the WAC Attainment Team must make for each waste lot wishing to use the EMWMF:

- DQO Decision 1: Does the waste lot data meet the form and format required by the WAC Attainment Team?

- DQO Decision 2: Is the existing waste lot characterization data sufficient to assess the waste lot SOFs?

- DQO Decision 3: Using a graded approach for the effects of SOF uncertainties on the VWSFs, can the waste stream be disposed at the EMWMF?

Each DQO Decision is presented in the following manner:

- Purpose of the decision (why we need the data)
- Inputs to the decision (what the data must represent and how they will be used)
- Tolerable limits on decision errors (how much uncertainty is tolerable)

E.4.1 KEY DECISIONS, INPUTS, AND DECISION ERROR

E.4.1.1 DQO Decision D1—Does the waste lot data meet the form and format required by the WAC Attainment Team?

1. Purpose of the decision (why we need the data)

   The purpose of Decision D1 is to confirm that waste lot characterization and quality assurance (QA) data are in a suitable form and format to be evaluated by the WAC Attainment Team, particularly in Decision D2. Within this decision is an evaluation of administrative WAC compliance and physical WAC compliance, as each of these WAC are essentially a checklist of requirements.

2. Inputs to the decision (What the data must represent and how they will be used)

   The data required to fulfill this decision are CERCLA documentation (especially if waivers to administrative WAC have been granted), characterization data, and the statistical parameters necessary to calculate waste lot SOFs and their uncertainties. Data will be confirmed as answering all administrative and physical WAC questions, and as being in the proper form and format to evaluate expected SOF impacts on VWSFs. If necessary, additional information can be requested from the RA project.

3. Tolerable limits on decision errors (How much uncertainty is tolerable)

   No decision errors are tolerable for Decision D1. The WAC Attainment Team insists on having 100% confidence that the data meets the form and format required by the WAC Attainment Team, and answers all administrative and physical WAC questions.

E.4.1.2 DQO Decision D2—Is the existing waste lot characterization data sufficient to assess the waste lot SOFs?

1. Purpose of the decision (why we need the data)

   The purpose of Decision D2 is to confirm that the waste lot characterization data is sufficient to assess its SOFs for impacts to the EMWMF VWSFs.

2. Inputs to the decision (what the data must represent and how it will be used)

   The data consist of data approved from Decision D1. Representative data include process knowledge, anecdotal evidence, and analytical data for all EMWMF RA project site-related contaminants (SRCs) that have analytic WAC limits. The underlying principle used to derive statistical goals for this decision revolved around a strong desire to ensure that, if a contaminant was present at a site, it was included in the calculation of the SOFs. A second underlying principle was that if a waste constituent actually was present at background levels, there was not as much concern over inappropriately carrying it forward as an SRC.

3. Tolerable limits on decision errors (how much uncertainty is tolerable)

   The WAC Attainment Team desires to be 95% confident that if the WAC Attainment Team determines a waste stream is approved (in terms of data sufficiency) such that it is ready to be examined during Decision D3, then the waste lot has truly demonstrated it has enough data to assess such an impact. The WAC Attainment Team will tolerate a maximum of a 20% risk that it will force the RA project to provide additional data when such data actually is not required. Effectively, these criteria translate into the confidence and power required for comparisons of site waste constituent concentrations to background values to screen them out as not being SRCs.

   The screening methodology in EPA's Risk Assessment Guidance for Superfund, Part A, were also incorporated to evaluate SRCs when background values are not available or when a constituent's data set contains mostly nondetected results. A screening criteria of less than 5% detects when a few nonqualified results are present, and less than 20% detects when all "detects" are estimated results ("J" flagged or equivalent), are prescribed.

E.4.1.3 DQO Decision D3—Using a graded approach for the effects of SOF uncertainties on the VWSFs, can the waste stream be disposed at the EMWMF?

1. Purpose of the decision (why we need the data)

   The purpose of Decision D3 is to decide whether a waste lot can be disposed at the EMWMF as proposed.

2. Inputs to the decision (what the data must represent and how it will be used)

   The data consists of data approved from Decision D2.

   The data will be used to determine the marginal impact of the waste lot SOF on the expected closure VWSF. There are three data sets of interest. The first is the actual EMWMF VWSF for materials currently in the cell. The second is the expected SOF and volume for the waste lot under consideration. The third is the expected VWSF of the wastes projected in the WGF to be disposed over the following 3 years. These together are used to calculate the expected 3-year VWSF.

3. Tolerable limits on decision errors (how much uncertainty is tolerable)

   The WAC Attainment Team desires to be 90% confident that when the WAC Attainment Team accepts a waste lot waste stream to be disposed at the EMWMF, the VWSF will not exceed 1. The WAC Attainment Team will also tolerate a maximum of a 10% risk a waste lot will be accepted for disposal at the EMWMF, when, in reality, the waste lot may force the expected EMWMF closure VWSF to exceed 1.

   A graded approach examines an expected waste lot's volume, expected SOF values, and associated uncertainties. The average values will be used to determine the marginal impact of the waste lot SOF on the EMWMF closure VWSF. If a waste lot has sufficient data to perform such an assessment, then no additional characterization information is required. If the waste lot has insufficient data, then additional characterization information is required. Note that the graded approach allows explicitly for uncertainty propagation on the VWSF to guide the need for further characterization requirements beyond those otherwise needed to address DQO Decisions 1 and 2.

E.4.2 BOUNDARIES OF THE DECISIONS AND THE DQO DECISIONS STUDY

Spatial and temporal boundaries of the problem and affected decisions are discussed below. Table E.2 illustrates that some decision variables and conditions are required for both configuration control and to address specifically the decision requirements.

Table E.2. Boundaries and general data requirements for all decisions

<table>
<tr><th>Boundaries and data requirement</th><th>D1</th><th>D2</th><th>D3</th></tr>
<tr><td>RA project wanting to use EMWMF
Historical RA project information and documentation
RA project waste shipment schedule</td><td colspan="3">Configuration Control variables</td></tr>
<tr><td>Administrative and physical WAC compliance
List of site-related contaminants and concentration (ppm or pCi/g)
Waste volume (yd^3 or ton)
Concentration and volume uncertainties</td><td rowspan="2">All data provided in consistent form and format</td><td>Key decision variables

(Using D1 data)</td><td>Key decision variables for graded approach

(Using D2 data)</td></tr>
<tr><td>Data sources and computational approaches
Data homogeneity (hotspots)
QA information (waste lot and assay)</td><td>Supplementary variables</td><td>Not applicable</td></tr>
</table>

EMWMF = Environmental Management Waste Management Facility
RA = response action
WAC = waste acceptance criteria

For example, configuration control variables are common for all decisions (i.e., it is necessary to know waste lot demand, schedule, and related information regarding use of the EMWMF). However when D3 is performed, it requires only volumes, SOF, and uncertainties.

E.5 DECISION LOGIC

The decision logic is one of the most valuable products of the DQO process Step 5, "Develop a Decision Rule." The decision logic illustrates primary and alternate courses of action to solve the problem identified in DQO Step 1.

Figure E.3 illustrates the decision logic for the three decisions discussed in the previous section. For any specific waste lot evaluated by the WAC Attainment Team, the parameters of interest are the expected volume, the expected SOF, the expected VWSF, and the associated uncertainties.

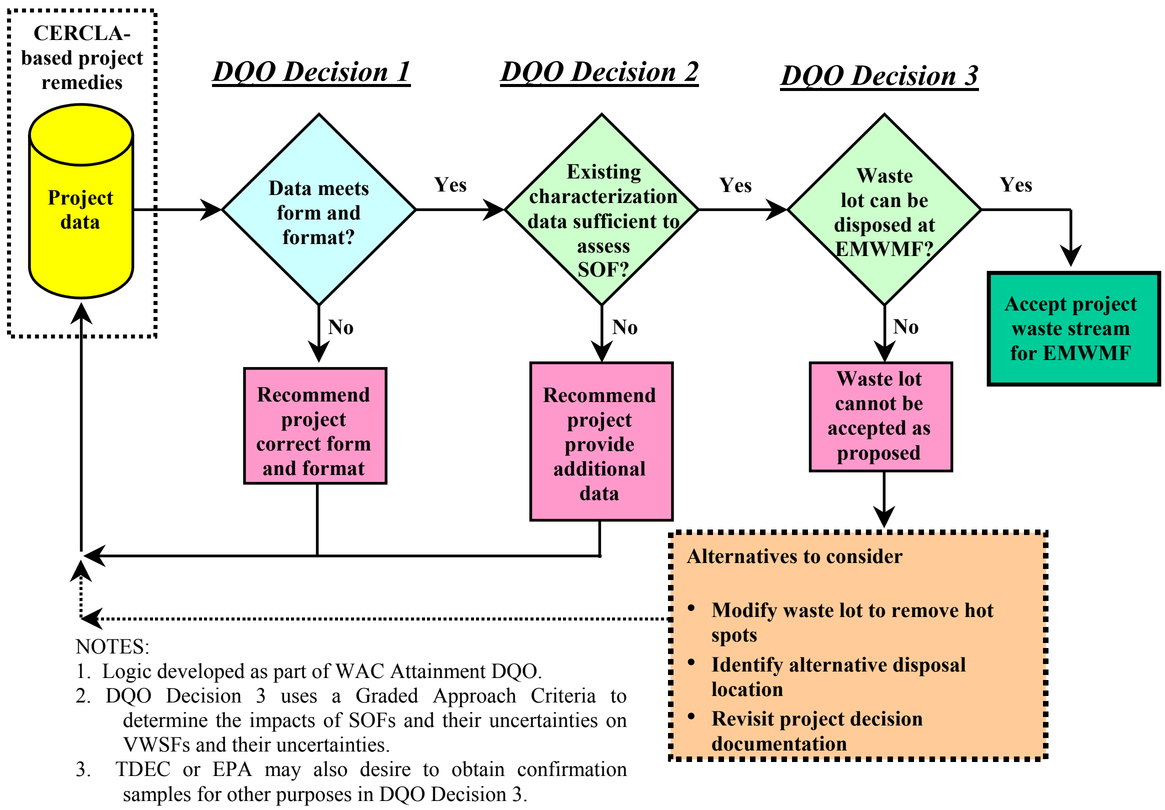

Fig. E.3. DQO decisions decision logic.

E.5.1 DQO DECISION D1—DOES THE WASTE LOT DATA MEET THE FORM AND FORMAT REQUIRED BY THE WAC ATTAINMENT BOARD?

The purpose of Decision D1 is to confirm that waste lot characterization data are in a suitable form and format to be evaluated by the WAC Attainment Team to support Decision D2. This includes any information needed to demonstrate compliance with the administrative and physical WAC. If the waste lot does not meet the criteria for D1, the WAC Attainment Team will request the deficiencies be corrected and the required information resubmitted.

E.5.2 DQO DECISION D2—IS THE EXISTING WASTE LOT CHARACTERIZATION DATA SUFFICIENT TO ASSESS THE WASTE LOT SOFS?

The purpose of Decision D2 is to confirm that the waste lot characterization data is sufficient to properly calculate SOFs (i.e., confirm that all SRCs are correctly identified). If the WAC Attainment Team decides that a waste lot has sufficient data to perform such an assessment, then no additional sampling information is required for this purpose. If the waste lot has insufficient data, then additional sampling information is required to address the identified data gap. When the waste lot does not meet the criteria for D2, the RA project has full responsibility for the generation of all required data.

E.5.3 DQO DECISION D3—USING A GRADED APPROACH FOR THE EFFECTS OF SOF UNCERTAINTIES ON THE VWSFS, CAN THE WASTE STREAM BE DISPOSED AT THE EMWMF?

The purpose of Decision D3 is to decide whether a waste lot can be disposed at the EMWMF as proposed. If the expected 3-year VWSF is > 1, the WAC Attainment Team will disallow the RA project to dispose its waste at the EMWMF as proposed. The RA project may elect to seek a waiver from the FFA Managers, segregate hot spots from its wastes in order to lower the average concentrations of the remainder, or off-site disposal options, etc.

All requests for additional sample data will utilize a graded approach, with waste lots that have a greater effect on the VWSF uncertainty being required to have more robust determinations of their SOFs than those with lesser effects on the VWSF uncertainty. This should lower the overall sampling cost for wastes being disposed in the EMWMF, though there may be higher sampling costs to certain key RA projects.

Within waste lots, further opportunities for reduced sampling costs can be realized by applying another graded approach that expends the greatest efforts sampling the specific waste contaminants most affecting SOF uncertainties. In this manner, the overall SOF uncertainty can be optimized, further optimizing the costs of reducing VWSF uncertainties.

In addition to any sampling performed by the prime contractor on behalf of DOE, the EPA or TDEC may choose to collect confirmation samples at their discretion.

E.6 CONCLUSION

EPA, TDEC and DOE have identified three DQO decisions key questions:

- DQO Decision 1: Does the waste lot data meet the form and format required by the WAC Attainment Team?

- DQO Decision 2: Is the existing waste lot characterization data sufficient to assess the waste lot SOFs?

- DQO Decision 3: Using a graded approach for the effects of SOF uncertainties on the VWSFs, can the waste stream be disposed at the EMWMF?

DOE, EPA, and TDEC have further agreed on the key decisions, the ground rules and data requirements, the decision logic, and the tolerable errors to guide decisions made by the WAC Attainment Team in whether to approve the RA projects to use the EMWMF as their disposal remedy.

E.7 REFERENCE

EPA (U.S. Environmental Protection Agency) 2000. *EPA QA/G-4, Guidance for the Data Quality Objectives Process*, EPA/600/R-96/05.

ATTACHMENT E-1

GLOSSARY OF DQO TERMS

This attachment presents a glossary of terms relevant to the DQO process as selected from "Guidance for the Data Quality Objectives Process," (EPA 2000) and various statistical references.

Action level The numerical value that causes the decision-maker to choose one of the alternative actions (e.g., compliance or noncompliance). It may be a regulatory threshold standard, such as a maximum contaminant level for drinking water; a risk-based concentration level; a technological limitation; or a reference-based standard. (Note: the action level is specified during the planning phase of a data collection activity; it is not calculated from the sampling data.)

Boundaries The spatial and temporal conditions and practical constraints under which environmental data are collected. Boundaries specify the area or volume (spatial boundary) and the time period (temporal boundary) to which the decision will apply. Samples are then collected within these boundaries.

Confidence The chance a decision-maker will conclude the alternative hypothesis is true when in reality it is. Another term used for confidence is "Power Function." This is defined as the probability of rejecting the null hypothesis over the range of possible population parameter values. The power function is used to assess the accuracy of a hypothesis test or to compare two competing tests.

Data quality objectives (DQOs) Qualitative and quantitative statements derived from the DQO process that clarify study objectives, define the appropriate type of data, and specify the tolerable levels of potential decision errors that will be used as the basis for establishing the quality and quantity of data needed to support decisions.

Data quality objectives process A quality management tool based on the scientific method, developed by the U.S. Environmental Protection Agency to facilitate the planning of environmental data collection activities. The DQO process enables planners to focus their planning efforts by specifying the intended use of the data (the decision), the decision criteria (action level), and the decision-maker's tolerable decision error rates. The products of the DQO process are the DQOs.

Decision error An error made when drawing an inference from data in the context of hypothesis testing. There are two types of decision errors:

A "False Negative Decision Error" occurs when the decision-maker does not reject the null hypothesis when the null hypothesis actually is false. In statistical terminology, a false negative decision error is also called a Type II error. The measure of the size of the error is expressed as a probability, usually referred to as "beta (β)". This probability is the complement of power or, equivalently, Confidence = Power = 1 - Type II Error.

A "False Positive Decision Error" occurs when a decision-maker rejects the null hypothesis when the null hypothesis actually is true. In statistical terminology, a false positive decision error is also called a Type I error. The measure of the size of the error is expressed as a probability, usually referred to as "alpha (α)." This probability is the also called the "risk." Sometimes, Risk = 1 - Confidence.

Hypothesis A logical statement made to draw out and test its logical or empirical consequences. In testing, there are two types of hypotheses. A "null" hypothesis is often called the "baseline" hypothesis. The "alternative" hypothesis is the logical statement upon which the burden of proof is placed. Thus, it is always desired to maximize the confidence of a hypothesis test and minimize the risk of a hypothesis test.

Hypothesis test The statistical process used to quantitatively reject or not reject a null and alternative hypothesis with some confidence and some risk.

Limits on decision errors The tolerable decision error probabilities established by the decision-maker. Potential economic, health, ecological, political, and social consequences of decision errors should be considered when setting the limits.

Mean (1) a measure of central tendency of the population (population mean), or (2) the arithmetic average of a set of values (sample mean).

Measurement error The difference between the true or actual state and that which is reported from measurements.

(N) Number of samples A computation based on (1) the desired confidence and risk, (2) the required detectable difference between the null hypothesis statistical parameter (e.g., a mean) and the alternative hypothesis statistical parameter, and (3) the variability of the statistical parameters' difference. The table below illustrates the qualitative impact on the number of samples due to these variables.

Population The total collection of objects, media, or people to be studied and from which a sample is to be drawn.

Sample

1. A single item or specimen from a larger whole or group.
2. A set of individual samples (specimens or readings) drawn from a population, 2 whose properties are studied to gain information about the whole.

Sampling The process of obtaining representative samples and/or measurements of a subset of a population.

Sampling design error The error due to observing only a limited number of the total possible values that make up the population being studied. It should be distinguished from errors due to imperfect selection; bias in response; and errors of observation, measurement, or recording, etc.

Standard deviation The square root of the variance.

Statistic — A function of the sample measurements (e.g., the sample mean or standard deviation).

Statistical test — Any statistical method that is used to determine which of several hypotheses is true.

Variance — A measure of (1) the variability or dispersion in a population (population variance), or (2) the sum of the squared deviations of the measurements about their mean divided by the degrees of freedom (sample variance).

REFERENCE

EPA (U.S. Environmental Protection Agency) 2000. *EPA QA/G-4, Guidance for the Data Quality Objectives Process*, EPA/600/R-96/05.